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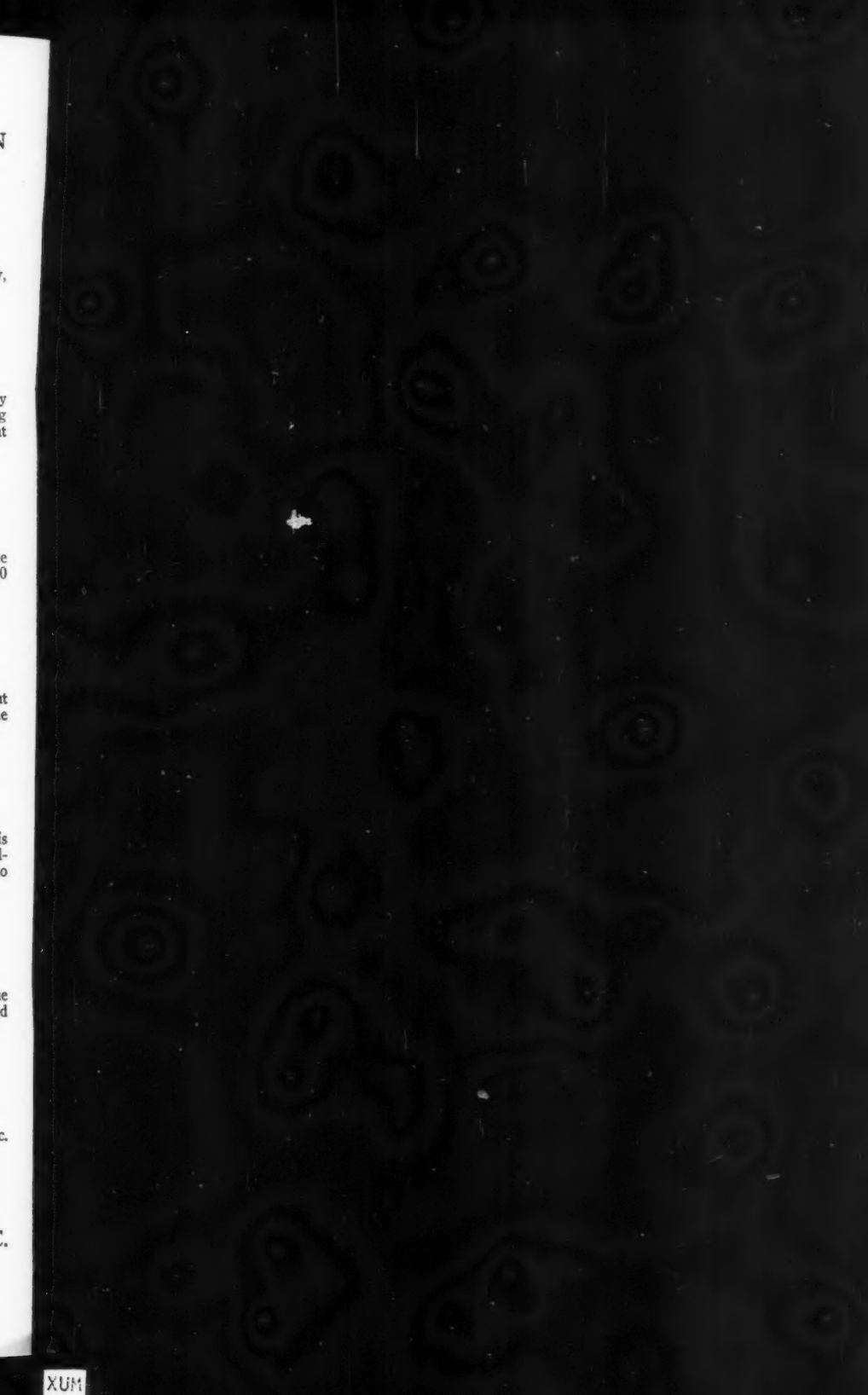

Journal of
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EXPERIMENTAL STUDIES IN AFFECTIVE PROCESSES: I. SOME EFFECTS OF COGNITIVE STRUCTURE AND ACTIVE PARTICIPATION ON CERTAIN AUTONOMIC REACTIONS DURING AND FOLLOWING EXPERIMENTALLY INDUCED STRESS

BY ERNEST A. HAGGARD*

Harvard Psychological Clinic

Within recent years, an increasing number of experimental psychologists have employed their specialized skills and techniques in an attempt to answer some of the vital questions propounded by psychiatrists and psychoanalysts. From the work with animal subjects, for example, much has been learned about the causal factors and necessary conditions for the development of the disorganized states that Pavlov called "experimental neurosis." Although such work indirectly sheds light on certain aspects of human behavior, the numerous investigations directly concerned with the affective reactions of human subjects in experimentally controlled situations have been much more fruitful in this respect.

This rapidly growing literature is much too extensive to be reviewed in detail here. But in connection with both the present experiment and the general problem of modifying emotional reactions, two classical studies should be mentioned. Watson and Rayner (84) conditioned Albert, a child of 11 months, to be afraid of white rats. This was achieved by making a loud noise which frightened the child whenever he reached out to touch the animal. After a few such trials, Albert cried at the sight of the rat, and was also afraid of other furry objects.[1] Later, Mary C. Jones (49) demonstrated that such

*The author is indebted to the Harvard Psychological Clinic in general and to Dr. H. A. Murray in particular for making this research possible.

[1] That 'emotional conditioning' involves more than the repeated presentation of such paired stimuli has been suggested by English (19) and Bregman (6), whose attempts with this procedure

avoidant reactions could be extinguished by employing the method of counter conditioning. That is, she gradually placed the feared object (a rabbit) closer to the child whenever a pleasant unconditioned stimulus (food) was being thoroughly enjoyed. As a result of this procedure, the child's reaction to the rabbit turned from fear to fondness. Following this work, similar experiments dealing with the 'treatment' of such varied conditions as alcoholism, allergy, enuresis, homosexuality, hysteria, and morphine addiction have been reported in the literature (**40**, p. 307). Generally, such attempts at 'symptom therapy' have shown that although the particular form of undesirable behavior may tend to disappear, the underlying causal conditions remain unchanged.

A somewhat different approach to problems of affective behavior was taken by Freeman and Pathman, who investigated one of the determinants of physiological recovery following experimentally induced frustration. From measures of overt muscular movements and palmar sweating (their index of autonomic activity) during and subsequent to the imposed stress, the authors conclude that those "individuals tend to recover internal equilibrium most rapidly who readily discharge aroused excitation by overt muscular action, even though this is apparently unadaptive." (**23**, p. 174) With this finding as a point of departure, Haggard and Freeman (**29**) found that children who reacted to a frustrating situation by directing their aroused energies on a relevant problem-task regained such internal equilibrium more rapidly than those who gave vent to their disturbance by such non-adaptive movements as restless fidgeting. Similarly, children who inhibited their overt expressions tended to show least recovery. These findings, then, confirm the commonsense observation that emotional adjustment is facilitated if a person *does something* (which is adaptive, if possible) when he is confronted by a stressful situation.

The present experiment was designed to investigate some of the factors involved in both the establishment and extinction of autonomic reactions to a situation involving stress induced by strong electric shock. In general terms, the purpose was to study the effect of various conditions which modified the magnitude and persistence of these reactions, both during and subsequent to the period of stress. In presenting the data, primary attention will be paid to (*a*) the extent to which the *S* assumed an active or passive role during the experiment, (*b*) whether or not the *S* was aware of the cues which always preceded the shock, and (*c*) the effectiveness of three 'thera-

were unsuccessful. However, H. E. Jones (**48**) in his work with young children used a slight shock (an 'uncomfortable tickle') paired with a bell to develop stable conditioning of overt emotional reactions. He found that "in spite of frequent extinction of the response (GSR), a C-R was shown to survive for at least seven weeks without reinforcement" (**47**, p. 496).

pies' or 'treatments' in modifying the autonomic reactions established during the initial conditioning session.

The Experiment

Subjects

The *Ss* were 18 college men who were paid for their time. Ten of this number (Clinic *Ss*) also underwent the complete series of examinations comprising the 1941–43 program of investigation at the Harvard Psychological Clinic. All *Ss* were unaware of the specific nature and purpose of the experiment.

Apparatus

The apparatus consisted of the following three units:

An *ink-writing galvanometer*[2] (General-Electric photoelectric recording microammeter, Catalogue No. 32C20) was placed in series with a Jr. Volt-Ohmist which was modified to accommodate the resistance ranges of the subjects (5,000–70,000 ohms), and a variable shunt which regulated the galvanometer's sensitivity. An external current of 2.5 microamps (45 volts D. C. in series with 2 megohms) was passed through the *S*. The Jr. Volt-Ohmist served as a linear Wheatstone bridge circuit and with the galvanometer recorded all changes in the *S*'s palmar skin resistance. A potentiometer on the Jr. Volt-Ohmist was used to buck out the majority of the resistance (determining the general level) while the galvanometer recorded all minor fluctuations (GSRs). The $\frac{7}{8}$ inch zinc cup electrodes on the *S*'s palms were protected from changes in position and pressure during the experiment by being placed in small boxes which were strapped to the hands. Standard Sanborn electrode paste was used to insure adequate contact with the palmar areas.

The *modified Luria-apparatus* consisted of two vertical plungers into which the *S* placed his index and fourth fingers of his right hand. By means of a wax-paper kymograph (25) a continuous record was obtained which registered simultaneously the occurrence of the stimulus words, the *S*'s verbal responses, and all movements of both fingers.

The *electric shock* was an instantaneous, alternating current (about 400 volts with 18 microamps) from a transformer, and was applied to the *S*'s right ankle for a fraction of a second through one-inch brass electrodes.[3]

Procedure

The total experiment consisted of three sessions, each of which was approximately 30–40 min. in length for all *Ss*. These three sessions, which followed each other in order within a two hour period were as follows:

During *Session I* the procedure was similar to Diven's (16). Here, *S* was comfortably placed in the apparatus and told that the test would not start for about five minutes, during which

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[2] The author is indebted to S. S. Stevens and R. Gerbrands for technical assistance in constructing and standardizing this unit.

[3] The author is well aware of the strength of this shock, since he underwent the experiment before subjecting anyone else to it. This shock strength was used to insure the *S*'s emotional involvement.

Tomkins (82) has recently stressed the importance of considering an individual's subjective reaction to electric shock. In this connection, statements from two *Ss* are given here. These comments are significant in so far as they stamp the situation as being roughly analogous to a minor trauma, and thus permits a generalization (to some degree at least) from the conditions and findings of this study to life experiences. The comments are:

"During the afternoon, which I spent trying to read in the library, the thought of the test came back at intervals. . . . That night my sleep was broken on several occasions for no good reason, which does not usually happen."

"I felt several times that I would just have to jump out of my chair and tell you to stop before another of those shocks, but when they came, they weren't nearly as bad as I was expecting."

(The material of this footnote, the instructions to the *Ss*, and Figs. 2, 3, and 4 are reproduced from Haggard (28) by permission of the President and Fellows of Harvard College.)

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time he should sit quietly and relax. This interval allowed sufficient time for polarization of the palmar areas to take place, enabled *S* to adapt somewhat to the apparatus, and was used to secure a record of *S*'s autonomic activity under non-stressful conditions. After this interval he was instructed as follows:

> "In this part of the experiment, a list of stimulus words will be read off, to each of which you are to respond by saying whatever words come into your mind. Press your index finger as you say every word. Keep on saying words and pressing your finger until I tell you to stop or until you feel the shock. It doesn't matter *what* words you say, so long as they are related to the one I give you. Also, it doesn't make any difference how far down you press your finger—just be careful that it is synchronized with your verbal response."

Any questions were answered, and *S* was given sufficient practice in coördinating his verbal-motor responses before the experiment proper was begun.

Each *S* was given 10–12 sec. for these chained associations after each stimulus word. The *S* was shocked only after the word *sword;* after all other words he was told 'Stop' at the end of the 10–12 sec. interval. Between the stimulus words, he was asked to "sit quietly and wait for the next one." This interval usually ranged from 20–40 sec., and was dependent on the time it took for the rate of palmar sweating to become stable (i.e., the end of the GSR).

The list was composed of 42 words, of which there were 10 'war' words (e.g., *machine gun*), 10 'peace' words (e.g., *recreation*), 5 repetitions of the 'pre-critical' word (*sharp*), 5 repetitions of the 'critical' word (*sword*), 5 'buffer' words which followed the shock (e.g., *tough*), and 7 remaining words, designed to elicit responses which might give clues indicating *S*'s personality structure (e.g., his name). This list was read off in the following order: trees, lake, gun, brook, *sharp*, *sword*, tough, sergeant, quiet, hate, tank, *sharp*, *sword*, soft, pleasure, brigade, farm, defense bonds, bomber, *sharp*, *sword*, strong, fireside, red cross, the *S*'s name, angry, recreation, *sharp*, *sword*, tender, fear, spitfire, experimenter, machine gun, fishing, mustard gas, meadow, *sharp*, *sword*, brave, love, and home. At the conclusion of this list, there was another rest period, which was in turn followed by a series of question regarding the experiment.[4]

In *Session II*, which followed immediately after Session I, each *S* was given one of the three therapies[5] described below. For the 10 *S*s in the Clinic Study, however, a slight irregularity was introduced. Immediately after the conditioning session, these *S*s were asked to fill out a short questionnaire concerning certain sentiments irrelevant to this experiment. Except for this interruption of about 10 min., the length of the period was comparable for all *S*s in each of the three groups.

Session III was the same as Session I for all *S*s except that no shock was administered. The purpose of this test period was to measure the relative effectiveness of the three therapies in alleviating the induced disturbance, and was measured by changes occurring in the general *level* or degree of autonomic activity and the magnitude of the GSRs to the specific words *sharp* and *sword*.

Experimental Conditions

Factorial design was employed to permit the simultaneous variation of the following two conditions: (*a*) in Session I, whether *S* was given the shock by *E* (*E*-shock) or gave it to himself (*S*-shock), and (*b*) in Session II, the use of one of the three therapies to alleviate or extinguish the autonomic reactions established during the conditioning session: *i.* Rest (R), *ii.* Experimental Extinction (EE), and *iii.* Catharsis-Information (C-I).

It was later found that another factor could also be studied, namely (*c*) whether *S* was Aware (A) or Unaware (U) at the end of Session I that the shock had always followed the stimulus word *sword*. For the two conditions in the original design, the number of *S*s in each treatment-group was the same. Thus, in both the *E*-shock and *S*-shock groups there were 9 *S*s, and in the R, EE, or C-I therapy groups there were 6 *S*s each, 3 being from the *E*-shock and 3 from the *S*-shock groups. The Aware-Unaware division will be described below.

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[4] See the discussion of *Data* (verbal).

[5] In this paper, the term 'therapy' will be used to designate *an experimental procedure*, the implications of which are essentially restricted to the conditions of the present study. This precaution is taken to avoid a too loose (and perhaps erroneous) generalization to the therapeutic procedures commonly employed by clinicians or psychiatrists.

The Administration of the Shock (Session I)

E-shock vs. S-shock Subjects.—The *S*s in the *E*-shock group were informed that they would be shocked occasionally during the session, but were not told when it would be. On the other hand, each *S* in the *S*-shock group was told that a light would occasionally appear on the apparatus before him, and that when this occurred, he was to press his fourth finger down about an inch until he heard a bell. Each *S*-shock subject was told that by pressing the plunger down far enough to ring the bell, he would automatically give himself the shock. It was made clear that the shock would be felt *only* after the sequence: light—finger pressure—bell. No *S* was told the strength of the shock.

Three points should be borne in mind in distinguishing between these two groups: (*a*) the *E*-shock *S*s were provided with no scheme of warnings that would enable them to 'get set' to receive the shock (i.e., the field was less structured for them), (*b*) these *S*s were passive with regard to the administration of the shock, while for the *S*-shock *S*s, receiving the shock involved a voluntary act, and (*c*) *all S*s were given the *same* shock (approx. 400 volts), the *same* number of times (5), the *same* number of seconds (10–12) after the *same* word (*sword*).

The Three Therapies (Session II)

Rest Therapy.—The *S*s given this treatment were told that they had 30 min. during which they could relax on a couch, sit in a chair, look at the pictures on the wall, or even leave the room provided that they did not discuss the experiment with anyone. No indication was given about the nature of Session III, except that it would start "in about half an hour."

Experimental Extinction Therapy.—The *S*s in this group experienced a duplication of Session I except that no shocks were administered. The three *E*-shock *S*s were not told that they had previously been shocked after the word *sword*, and the three *S*-shock *S*s again pressed their fourth finger when the light appeared, but of course received no shocks. Nothing was said about the nature of Session III.

Catharsis-Information Therapy.—These *S*s were asked to make themselves comfortable by lying on a couch or sitting in a chair, and were encouraged to express any feelings (e.g., resentment, anger, fear) which they had experienced during Session I. In an attempt to facilitate a free expression of these feelings, the *S*s were told:

> "Now that we are finished with that part of the test, I'd like to know what you thought of and how you felt about it. You can say anything you wish, and above all be frank and honest. Will you tell me, for example, what passed through your mind each time you were shocked, what you thought of and how you felt between the shocks, and how much the shock frightened or angered you."

Since these *S*s never talked for more than a part of the session, *E* inquired regarding any overt signs of emotional disturbance (e.g., remarks, gestures, blocking on certain stimulus words) which were manifest during the conditioning session. In this manner, *S* was asked to give his associations to or comments regarding his reactions during the first session. In addition, the *S*s in this group were given an opportunity to ask any questions concerning the nature and purpose of the experiment. (An invariable question was whether they would be shocked again.) In every instance, they were given truthful answers. Thus, only the *S*s in this therapy group were informed (verbally) that there would be no additional shocks.

Aware vs. Unaware Subjects

At the end of Session I, the *S*s were asked if, by the end of the period, they were able to predict when the shocks would come. Nine of the 18 discovered, or were *Aware*, that it followed the word *sword*, seven had no idea when it came, but were certain that it had not come at any particular time or after any given word, and two were uncertain whether it came after *sword* or some other war word. For convenience in treating the data, these last two *S*s were placed in the *Unaware* group. Of the seven definitely Unaware *S*s, five were in the *E*-shock and two in the *S*-shock groups, suggesting that the conditions involved in the self-shock facilitated structuration of the cognitive field.[6]

[6] That 'awareness' or 'unawareness' is determined partly by the nature of the experimental conditions (*E*-shock or *S*-shock) and partly to differences in the *S*'s attitude toward the situation is indicated by two findings: (*a*) there were more *E*-shock *S*s in the Unaware and *S*-shock *S*s in

Data

The data obtained included records of all changes in palmar skin resistance,[7] all finger movements (both fingers), and various verbal responses. For the 10 *S*s who took part in the Clinic Study, all associations to the stimulus words were recorded, and for all 18 *S*s, the number and time of their responses, the number of words they could recall after the first session, the *S*'s estimation of the total number of stimulus words, the subjective strength of the shock, the number of shocks, and answers to several questions regarding individual reactions to the experimental situation were noted.[8]

Results

The results in this section are presented with the following two considerations in mind: (*a*) whether there is any difference in the magnitude and persistence of certain manifestations of autonomic activity between the *E*-shock and *S*-shock, among the R, EE, and C-I therapies, or between the Aware and Unaware groups, and (*b*) for these groups, what can be said regarding changes in the general *level* of autonomic activity, and changes in the specific reactions (GSRs) to the pre-critical word *sharp* and the critical word *sword*. All measures are expressed in terms of Log C. units, and indicate the average (mean) score for the particular group being considered.

Session I

E-shock vs. S-shock Subjects

1. Changes in General Level.—As a result of the electric shocks, there was a marked increase in the extent of autonomic activity as measured by the general level of palmar resistance for both sets of *S*s. That it was much greater for the *E*-shock group is indicated when the ohmic changes for the two sets of subjects are compared. Here we find that the average fall in resistance for

---

the Aware groups, and (*b*) a correlation ($r\phi$) of .75 was found between those *S*s who *tried* to find out and those who *did* find out that the shock followed the word *sword*. This correlation, however, is based on 33 cases from a subsequent series of investigations, the experimental conditions of which were in all essential respects the same as those of the present study. From this fact, the assumption is made that a similar trend holds for the group of *S*s who served in the present study.

[7] *a.* This measure was employed on the following grounds: (*a*) the degree of palmar sweating is dependent upon the activity of the autonomic fibres and the sweat glands they innervate, and (*b*) increased activity is considered an 'index of emotion' only in the sense that the autonomic changes represented are one of the systemic mechanisms involved in the mobilization of energy resources in the face of emergency or stressful situations such as the present experiment.

b. It is generally held that the GSR (which is due to a momentary increase in an existing rate of palmar sweating) is an indication of the sign-value or meaning (conscious or unconscious) that a specific stimulus has for the *S*. However, the *general level* of palmar sweating is primarily dependent on the gross, over-all pattern of sympathetic excitation. Other things being equal, the level of palmar sweating of an *S* in a 'non-stressful' situation (that is, if he is quiet, peaceful, relaxed, etc.) is characterized by a high level of resistance, or low conductance, while the level of a person in an 'emergency' situation (that is, if he is very alert, anxious, angry, etc.) is characterized by low resistance, or high conductance.

c. In regard to the evaluation of the minor fluctuations in the *S*'s palmar resistance (GSR), several methods of treating the raw resistance scores have been suggested. The two most justified from a theoretical point of view involve the use of *conductance units*, or the reciprocal of the resistance (**22**) and *log conductance units*, or the logarithm of the reciprocal (**14**). Both of these transformations weight more heavily the ohmic changes which occur in the lower resistance ranges (e.g., 6000 rather than 40,000 ohms resistance of the *S*) *in an attempt to derive units which are behaviorally equivalent.* In the present study, the use of log conductance (Log C.) units was arbitrarily chosen, since the weightings of this scale are more conservative for the lower resistance ranges and are more uniform throughout the total range. With regard to the data presented in this paper, then, the assumption is made that all units are of equal significance, so that a change of 10 Log C. units is considered to be twice as great as a change of 5 units, regardless of the level of the resistance range in which the change occurred. An *increment* in Log C. units is indicative of an increase, and a *decrement* of a decrease in autonomic activity.

[8] See Haggard (**28**) for a report of various inter-relationships among the verbal, motor, and autonomic reactions of the subjects in this study.

the *E*-shock group was 8420 ohms while for the *S*-shock group it was 3400 ohms. More precisely, the average increase in autonomic activity for the *E*-shock group was 17.2 units, and for the *S*-shock group it was 8.6 units.[9] The significance of the increase for the former group ($t = 2.60$) falls at the .03 level, while for the *S*-shock group ($t = 2.13$) this value lies at the .07 level of significance.[10]

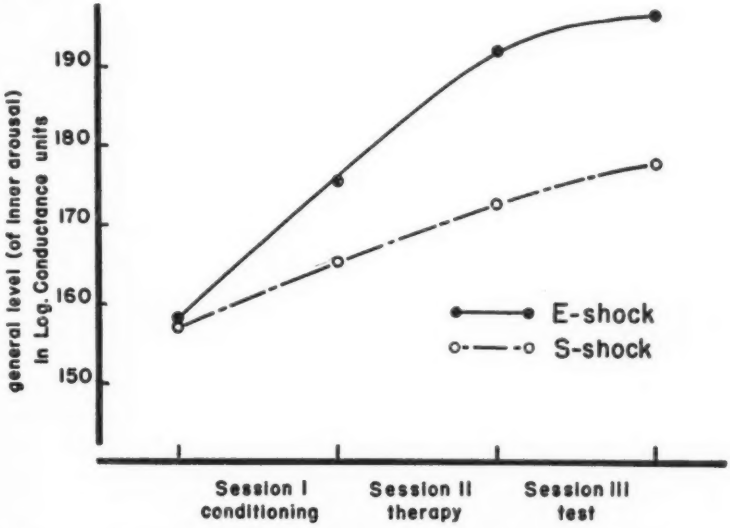

FIG. 1. The relative increase in the general level of palmar skin conductance between the *E*-shock and *S*-shock groups for the three sessions.

In Fig. 1 we see that if the relative increment for the two groups is compared, the *E*-shock subjects showed a significantly greater increase in autonomic activity during the conditioning session. The *P*-value for this difference ($t = 2.66$) lies at the .02 level. From this finding we can conclude that whatever factors are involved in the conditions of *E*-shock or *S*-shock made a significant difference in determining the extent to which the autonomic mechanism was activated. This is true in spite of the fact that such features of the situation as the strength, spacing, and number of the shocks were identical for both groups of *S*s.

2. Changes in Reaction (GSR) to the Word Sharp.—By the end of Session I, both sets of *S*s showed an increased GSR to this word. With the *E*-shock group, however, this increase was 3.9 units, or 2.2 times as great as that of the *S*-shock group, which showed an increase of only 1.8

[9] The scores for measures of *level* were obtained by averaging the *S*s' levels for the first and last five words in Sessions I and III. The scores for Session II were obtained by using the average level for the last five words of Session I and the first five in Session III. The measures for *sharp* and *sword* were similarly obtained by averaging the first two and last two GSRs to these words during Sessions I and III, and the measures for Session II were obtained as described above. This procedure was necessary since the R and C-I groups (i.e., $\frac{2}{3}$ of the *S*s) did not yield autonomic records during Session II.

[10] Since the critical ratio is both biased and unstable for small samples, the appropriate *t*-tests were used in this study to measure the significance of the differences between the various groups of subjects. For the differences *between* groups (e.g., *E*-shock and *S*-shock), the *P*-values are based on 17 degrees of freedom, and for the differences *within* groups (e.g., *E*-shock or *S*-shock), the *P*-values are based on 8 degrees of freedom.

units.[11] More specifically, while the increase for the *S*-shock group was not significant ($t = .99$; $P = .35$), the increase of the *E*-shock group ($t = 2.30$) falls at the .05 level. That the two groups distinguished themselves on this measure is further indicated by the fact that the relative difference in the increase in the GSR ($t = 2.48$) falls at the .03 level of significance.

3. Changes in Reaction (GSR) to the Word Sword.—It should be noted that *during Session I, the GSR attributed to the word sword is actually a measure of S's autonomic reaction to the electric shock.* In Fig. 3 we see that here also, *S*s in the *E*-shock group showed a greater average reaction throughout the session than did those in the *S*-shock group. In evaluating the adaptation of the *S*s experiencing the shock under these two conditions, we find that the significance of the decrease of the *E*-shock *S*s ($t = .68$, $P = .54$) is substantially less than that of the *S*-shock group ($t = 1.95$, $P = .09$).[12] The difference between the two shock groups in their reaction to the shock during Session I was significant ($t = 2.39$) at the .04 level.

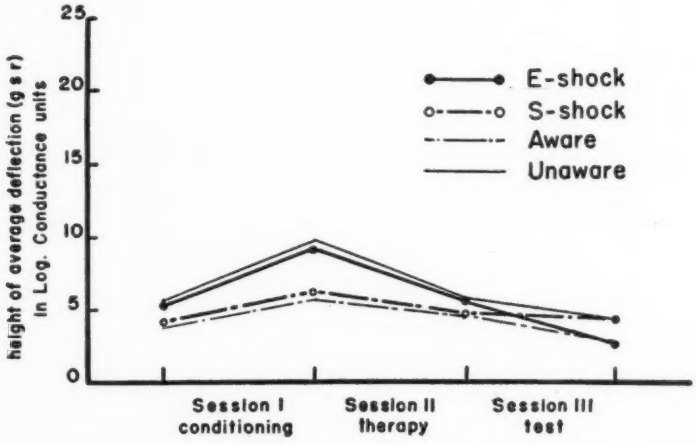

FIG. 2. The relative size of the momentary changes in palmar skin conductance (GSR) for the *E*-shock, *S*-shock, Aware and Unaware groups during the three sessions to the pre-critical word *sharp*.

Further evidence of the relationship between the differences in the administration of the shock and the magnitude of these autonomic reactions is indicated by the following correlations (r_{bis}) which were found to exist between the *E*-shock and *S*-shock groups and the increase in the general level of autonomic activity, .51, with the degree of conditioned anticipation (GSR to *sharp*), .64; and with the autonomic reactions to the electric shock, .64.

These results due to differences in the administration of the shock cannot be accounted for in terms of such objective conditions as variations in the strength or number of the shocks, the length of the session, etc. It seems, rather, that these discrepancies result from differences in (*a*) the degree of cognitive structure (i.e., whether *S* knew when the shock was coming, and so could 'get set' for it), and (*b*) whether the shock was self-administered or passively received.

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[11] Fig. 2 shows that the *E*-shock group started out at a slightly higher level (5.1 units) than did the *S*-shock group (4.2 units). This difference may be accounted for by recalling that these values were the average of the first two scores, indicating that the groups began to distinguish themselves early in the session.

[12] This statement seems to conflict with Fig. 3, in which the average decrement in the size of the GSRs is almost the same for both groups. The explanation of the low *P*-value for the *E*-shock group is the larger variability among the scores of the *S*s in this group.

Aware vs. Unaware Subjects

4. Changes in General Level.—The Aware and Unaware groups did not clearly differentiate themselves in their general reactions to the conditioning session ($t = 1.19$; $P = .30$) as had the *E*-shock and *S*-shock groups.

5. Changes in Reaction (GSR) to the Word Sharp.—As will be seen in Fig. 2, the average GSR of the Unaware *Ss* to this word was substantially greater than the reactions of *Ss* in the Aware group. In terms of significance levels, the Unaware group showed an increase ($t = 2.97$; $P = .02$) which was much larger than that of the Aware *Ss* ($t = 1.0$; $P = .35$). The significance of the difference between the two groups ($t = 1.29$) falls at only the .23 level, although the Unaware *Ss* showed an average increase on this response which was 2.6 times as great as that of the Aware group.

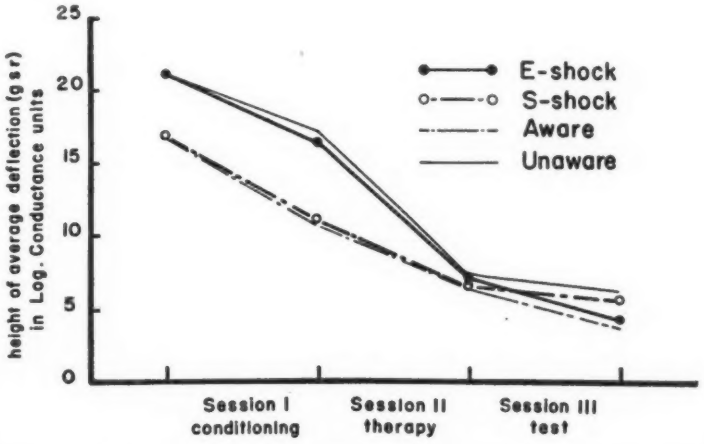

FIG. 3. The relative size of the momentary changes in palmar skin conductance (GSR) for the *E*-shock, *S*-shock, Aware, and Unaware groups during the three sessions to the word *sword*. During Session I, these responses indicate the *Ss*' reactions to the electric shock as well as to the critical word *sword*.

6. Changes in Reaction (GSR) to the Word Sword.—As shown in Fig. 3, the Unaware group as a whole averaged the greatest and the Aware group the least reaction to the electric shock during the conditioning session. While the decrease of the Aware *Ss* ($t = 2.05$; $P = .08$) was 1.9 times as great as that of the Unaware *Ss* ($t = 2.37$; $P = .05$), the large variability among the scores of these *Ss* precludes any clear-cut statistical distinctions in terms of *P*-values. The difference in the relative rate of adaptation for the two groups ($t = .92$) was significant at the .36 level.

Although the Aware and Unaware groups are made up of both *E*-shock and *S*-shock *Ss*, the average scores on the words *sharp* and *sword* during this session are almost identical for the two sets of *Ss*. The fact that we find such trends for the two subject classifications again suggests the influence of the two factors mentioned above. Table I, in which the *Ss* are divided into subgroups, shows that those *Ss* who possessed the greater degree of cognitive structure and who took an active role with regard to the administration of the shock showed the smallest average GSRs to the word *sharp* and to the electric shock.

7. Average Size of the GSRs.—Other things being equal, it is generally assumed that the size of the GSR is proportional to and indicative of the meaningfulness or sign-value that a specific stimulus has for a given *S*. Generalizing, if the GSRs to all words in the list are considered, a measure is obtained of the general over-all significance of the situation, which in turn may be used as a rough approximation of the degree of 'emotionality' manifested by a given *S*.

TABLE I

THE AVERAGE DEGREE OF CONDITIONED ANTICIPATION AND REACTION TO THE ELECTRIC SHOCK FOR THE FOUR SUB-GROUPS DURING SESSION I

Measurements are in terms of Log Conductance units

Sub-group	Number in Group	Size of GSRs to *Sharp* at end of Session I	Initial GSRs to the Electric Shock
S-shock—Aware	5	.3	12.2
S-shock—Unaware	4	3.2	18.2
E-shock—Aware	4	3.7	16.1
E-shock—Unaware	5	4.1	25.1

With this point of view in mind, the average GSR was obtained for all *S*s, and comparisons made between the various groups. As a result, we find that (for all 42 words) the average GSR of the *E*-shock group was only 1.2 times as great as that of the *S*-shock *S*s during the first session. This difference is far from significant. In contrast to this finding, the average GSR of the Unaware group for all words was 2.2 times as great (and also 2.2 times as variable) as that of the Aware *S*s. Furthermore, when the responses to the word *sharp* and to the electric shock are omitted, the ratio remains unchanged. This difference ($t = 2.27$) is significant at the .04 level. Corresponding to this discrepancy is a correlation (r_{bis}) of .57 between the factor of awareness and the average size of the GSRs.

Session II

E-shock vs. S-shock Subjects

8. Changes in General Level.—All groups except the *S*-shock—C-I therapy sub-group showed varying degrees of increment in the general level of autonomic activity during this session. This finding may be due in part to the method of measuring this change, which was to take the difference between the general levels of the last part of Session I and the first part of Session III. Thus,

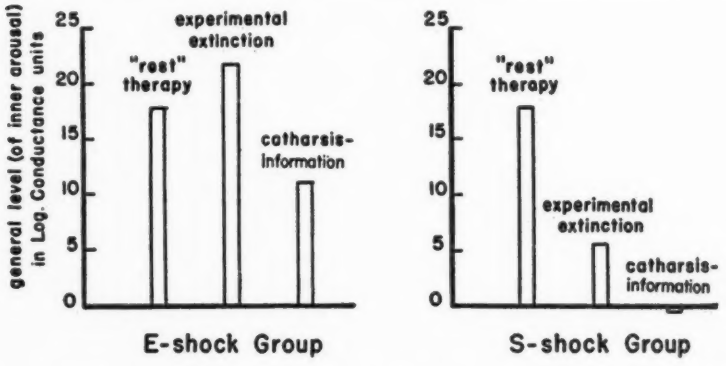

FIG. 4. The relative increase in the general level of autonomic arousal during Session II for the conditions of shock and therapy.

when *S* was placed in the apparatus at the start of Session III and given a treatment identical with that beginning Session I, it seems probable that the recurrence of the many cues present in the conditioning session tended to reinstate the previous generalized disturbance.

If the values for the *E*-shock and *S*-shock groups (e.g., the heights of the columns in Fig. 4) are averaged, the increment in general disturbance for the *E*-shock *S*s is found to be 2.2 times as

great as that of the *S*-shock group. Because of the variability due to the differential effectiveness of the therapies within the shock groups, the *t*-value is only 1.60, and falls at the .13 level of significance.

9. Changes in Reaction (GSR) to the Word Sharp.—Although records of palmar sweating were available for only the six *Ss* given EE therapy, these findings deserve to be mentioned. For the *E*-shock group during Session II, there was an average decrement in the GSR of 1.0 units, while the *S*-shock group showed an average *increment* of .7 units at the end of the extinction trials. Furthermore, during this session the total *E*-shock group (i.e., all three therapies combined) showed an average decrement of 2.0 units ($t = 1.79$; $P = .11$) and the *S*-shock group one of .6 units ($t = .84$; $P = .43$). The difference between these groups ($t = 1.78$) falls at the .10 level of significance.

10. Changes in Reaction (GSR) to the Word Sword.—As with the pre-critical word, the average decrement in the size of the GSR to *sword* was greater for the *E*-shock group. For those given EE therapy, the average decrement for the *E*-shock *Ss* was 4.5 units while for the *S*-shock group it was 2.0 units. Similarly, for the total *E*-shock group, the average decrement was 4.7 units ($t = 2.42$; $P = .05$), while for the *S*-shock *Ss* it was 2.3 units ($t = 1.88$; $P = .10$). The relative difference in the extinction rates of these groups is indicated by a *t* of 1.85, which falls at the .09 level of significance.

The Three Therapies

11. Changes in General Level.—Figs. 4 and 5 show the relative degree to which the three therapies were effective in checking the increase in the level of autonomic activity in each subgroup. It should be noted that there were marked differences among the three procedures in (*a*) the degree to which *S* was required to confront the conditioning session, and (*b*) in the amount of information (particularly regarding the shock, the primary source of disturbance) provided during the second session. Thus, in a sense, Figs. 4 and 5 may be said to depict the interacting influence of those two factors, and picture the degree to which they were effective for the four groups of *Ss* (*E*-shock, *S*-shock, Aware, and Unaware) and the three therapies (R, EE, and C-I). Likewise, the *Ss* given Rest therapy may be considered as controls, so far as 'therapy' is concerned, and the deviations from the scores of this group may be said to indicate the presence or absence of the factors determining the effectiveness of the therapies.

In general, Rest therapy was the least effective, as shown by an average increment of 17.6 units during this session, the EE therapy somewhat more effective, with an average increment of 13.6 units, and the C-I therapy the most effective, with an average increment of 5.2 units. The influence or role of the above mentioned factors is further indicated when the columns for the two shock groups are compared for each of the three therapies. Between the R and EE groups, the average difference was 4.0 units ($t = .84$; $P = .45$), between the EE and C-I group it was 8.4 units ($t = 1.75$; $P = .17$), and between the R and C-I groups it was 12.4 units ($t = 3.07$; $P = .03$).

If comparisons are made between the *E*-shock and *S*-shock groups with regard to a particular therapy, we find that the values for both the R groups were the same (17.6 units). For the EE groups, however, the *E*-shock *Ss* showed an increment which was 3.8 times as great as that of the *S*-shock *Ss* (21.4 vs. 5.7 units). The difference between the C-I groups is equally marked with the *E*-shock *Ss* showing an increment of 11.0 units, and the *S*-shock group a slight decrement of .6 units.

12. Changes in Reaction (GSR) to the Word Sharp.—The differential effect of the therapies in modifying the GSR to this word is indicated by the degree to which this response tended to extinguish for the three groups. There was an average decrement in the size of GSR of 2.4 units for the R group, of .1 units for the EE group, and of 1.3 units for the C-I group. The difference between these rates of extinction to *sharp* is furthermore indicated by an *F*-value[13] of 2.52 ($P = .10$) for those therapies. Moreover, the interaction between the factors of shock and therapy yields an *F* of 6.62, which falls at the .02 level. These findings may be said to result from the fact that a decrement in the size of the GSRs was inversely proportional to the degree of (peripheral) reinforcement involved during both the conditioning and therapy sessions.

13. Changes in Reaction (GSR) to the Word Sword.—There are no clear-cut differences in the effect of the therapies on the rate of extinction of the GSRs to the word *sword*. The average decrement for the R group was 3.7 units, for the EE group, 3.3 units, and for the C-I group, 3.4 units.

[13] Analysis of variance, with 2 and 12 degrees of freedom.

Aware vs. Unaware Subjects

14. Changes in General Level.—Those *S*s who were unaware that they had been shocked after *sword* during the conditioning session showed an increase of inner arousal during the therapy session which was 1.6 times as great as that of the Aware group. In Fig. 5, it is seen that the columns for the Unaware group are in every case taller than those of the Aware *S*s. These differences must be attributed to the role of such a central factor as cognitive structure, since both the *E*-shock and *S*-shock *S*s composed these groups.

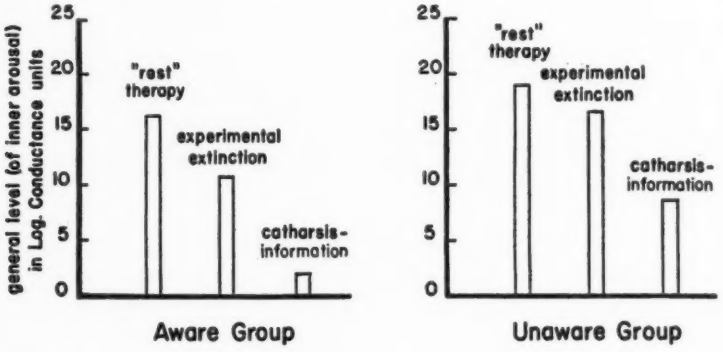

FIG. 5. The relative increase in the general level of autonomic arousal during Session II for the conditions of awareness and therapy.

15. Changes in Reaction (GSR) to the Words Sharp and Sword.—The average decrement in the GSR for the Aware group was .6 units for the word *sharp*, while for the Unaware group it was 2.1 units. Similarly, the response to *sword* showed an average decrement of 2.0 units for the Aware group and 5.0 units for the Unaware *S*s.

Session III

E-shock vs. S-shock Subjects

16. Changes in General Level.—As shown in Fig. 1, there is almost no difference in the relative increase in the general degree of autonomic activity between the two groups during Session III. In terms of resistance changes, *S*s in the *E*-shock group showed a decrease of 2530 ohms, while the *S*-shock group showed an average decrease of 2600 ohms. More precisely, there was an increment of 4.7 units for the *E*-shock group and of 5.2 units for the *S*-shock group—a difference which is insignificant.

17. Changes in Reaction (GSR) to the Word Sharp.—There was almost no extinction of the GSR to this word for the *S*s in the *S*-shock group, while a substantial decrement appeared for those in the *E*-shock group. For the former *S*s, the drop was only .4 units ($t = .64$; $P = .58$) but for the latter group it was 2.3 units ($t = 2.10$; $P = .05$). It will be observed in Fig. 2 that although the reactions of the *E*-shock group were greater at the beginning of the session, the *S*-shock group manifested a substantially larger GSR at the end of the period. The significance of the difference in the relative rates of extinction between these two groups is indicated by a *t*-value of 2.95, which falls beyond the .01 level.

18. Changes in Reaction (GSR) to the Word Sword.—Again, the rate of extinction for the *S*-shock group on this word was less than that of the *E*-shock group. For the latter *S*s, the average decrement was 2.7 units ($t = 1.57$; $P = .16$), and for the *S*-shock group it was 1.0 units ($t = 1.07$; $P = .34$). While the average GSR was greater for the *E*-shock group at the beginning and less at the end of this session (see Fig. 3), the relative difference between the two groups is not so clear-cut ($t = 1.02$; $P = .33$) as in the case of the word *sharp*.

The Three Therapies

19. Changes in Reaction (GSR) to the Word Sharp.—The EE group during Session III showed an average decrement in the GSR of 2.1 units, which was greater than that for either the R group (.9 units) or the C-I group (.9 units). On first glance, this seems to contradict the findings of Session II, in which the EE *Ss* clearly showed greater resistance to the extinction of this response. It should be noted, however, that within the EE group, the *S*-shock *Ss* showed an average drop of only .9 units, while the *E*-shock *Ss* showed an average drop of 3.3 units. The greater degree of extinction in the EE group may be due in part to the fact that by the end of Session III, these *Ss* had experienced twice as many non-reinforced trials (i.e., 10 rather than 5) as had either of the other two groups.

20. Changes in Reaction (GSR) to the Word Sword.—As with the pre-critical word, the EE group manifested the greatest degree of extinction of the response to the word *sword*. For the total groups, the R *Ss* showed a decrement of 1.3 units, the EE of 3.1 units, and the C-I of 1.1 units. However, in examining the EE groups we again find that the *E*-shock *Ss* are responsible for most of this effect with a drop of 4.7 units, while the *S*-shock *Ss* showed an average decrement of 1.5 units. This latter fact is consistent with all the other data, showing that the *S*-shock *Ss* regardless of other factors, display much less extinction of the GSR to the words *sharp* and *sword*. It further indicates that so far as the extinction of the GSRs to specific stimuli in the total situation is concerned, the *Ss* in the *E*-shock—EE therapy sub-group showed the greatest extinction of these responses by the *end* of Session III.

Aware vs. Unaware Subjects

21. Changes in Reaction (GSR) to the Word Sharp.—The differences between the Aware and Unaware groups in rate of extinction of the GSR are not nearly so marked as are those between the *E*-shock and *S*-shock groups. The average decrement for the Aware *Ss* is .9 units and for the Unaware is 1.4 units, a difference ($t = .59$) which falls at the .56 level.

22. Changes in Reaction (GSR) to the Word Sword.—The average decrement of the Aware group was 2.5 units, and for the Unaware was 1.0 units. Although a difference exists between the extinction rates of these two sets of *Ss* ($t = .93$), it only falls at the .36 level.[14]

Furthermore, in Figs. 2 and 3 we see that the decrement of the GSR for the Aware and Unaware groups to the words *sharp* and *sword* follow somewhat parallel paths, and do not cross each other as do the values for the *E*-shock and *S*-shock groups. In other words, the *Ss* who made a self-initiated, overt response in connection with the shock at the presentation of the light, and continued to make such a response during this session tended to show little if any extinction on the non-reinforced trials.

23. Average Size of the GSRs.—During this final session, the average GSR of the *E*-shock group (for all words) was only slightly larger (2.11 vs. 2.07 units) than that of the *S*-shock *Ss*. This lack of difference supports the position that the *Ss* composing these two groups may be thought of as belonging to the same statistical population (under non-stressful conditions)—at least in so far as these measures of the autonomic reactions are concerned. Consequently, the differences between the reactions of these two groups when the various conditions are imposed may be attributed to the effect of these treatments.

During this session, the Unaware group showed a GSR which was only 1.2 times as great as that of the Aware group. This relatively slight difference (as compared with that of Session I) indicates that these two groups react differently under stressful, but similarly under non-stressful conditions. In other words, it may be said that the Aware and Unaware groups differentiated themselves primarily with regard to their ability to tolerate the stress involved during the conditioning session.

Sessions II and III

24. The 'Second Therapy Session.'—While the third session has thus far been considered as a test period which was employed to measure the relative effectiveness of the R, EE, and C-I therapies in the extent to which they served to modify the autonomic reactions initiated by the electric shock, it may also be thought of as a second therapy session (EE) which follows one of the three procedures of Session II. It is difficult, however, to make any statements of the sig-

[14] It is possible, though, that the difference which does exist indicates the influence of information on the rate of extinction, since the Aware *Ss* showed a drop which was 2.5 times as great as that of the Unaware group.

nificance of the changes occurring during Session III, since the therapies of Session II were so dissimilar. But if Sessions II and III are considered together, we have an indication of their combined effectiveness in modifying the general processes and specific reactions induced during the first session.

The average change in the reactions of the *S*s in all sub-groups during Sessions II and III on measures of both the general aspects (*level*) and the specific reactions which were associated with the shock, either indirectly (*sharp*) or directly (*sword*) during the conditioning session may be briefly summarized as follows: (*a*) with regard to the general level of autonomic excitation, the therapies were 1.5 times as effective for the *S*-shock *S*s, (*b*) the average decrement in the reactions to the word *sharp* was 4.3 times as great for the *E*-shock *S*s, and (*c*) the average decrement in the size of the reactions to *sword* was 2.4 times as great for the *E*-shock as for the *S*-shock *S*s.

25. Reactions to Specific vs. General Aspects of the Situation.—In general, there are two aspects of an individual's adjustment to a threatening or stressful situation, (*a*) his reactions to particular objects or events in the total situation-context, and (*b*) a state of affairs which may be roughly spoken of as inner arousal, generalized disturbance, anxiety, or apprehension. That both of these factors exist and may vary independently is borne out by the present data. For example, during Session II the *S*s in the *S*-shock—C-I sub-group showed a slight decrement in general autonomic arousal (*level*), but only a relatively slight extinction of the reactions (GSRs) to the words *sharp* and *sword*. On the other hand, *S*s in the *E*-shock—R-therapy sub-group manifested a substantial increase in the degree of general arousal, but also showed the largest decrement in the size of their GSRs to the stimulus words *sharp* and *sword*. This trend showing the differential effectiveness of the three therapies in alleviating induced reactions to the specific and general aspects of the experimental situation is further indicated by the correlations (rho) calculated between the measures of *level*, and the reactions to *sharp* and *sword* for Sessions II and III combined. The following trends were found to exist: between *level* and *sharp*, −.46; between *level* and *sword*, −.67; and between *sharp* and *sword*, .78. From these indices, we find that such an inverse relationship obtains more often than not for the therapies used in this experiment. In this case, then, a procedure which was effective in 'treating' generalized disturbance tended to be relatively ineffective in extinguishing reactions to specific aspects of the situation, and vice versa.

Discussion

I. *The Role of the Central Factor (Cognitive Structure).*—During the last decade or so, most experimental psychologists have come to assume the point of view that human behavior cannot be properly evaluated unless *more* is taken into account than the observable stimulus-response relationships. Razran (**73**, p. 224), in speaking for this broadened orientation, pointed out in 1934 that "the history of psychology of the last twenty years has shown that oversimplification and 'reduction' have made little headway toward solving some very persistent psychological problems, and after all it is not so much the clarification of one or another isolated phenomenon as the interpretation of the dynamic totality of human behavior that is at stake."

Numerous experimental studies have demonstrated the importance of such central factors as the *S*'s attitude toward the experimental situation or his knowledge of its purpose. Familiar examples include studies of simple reactions (e.g., **60**, **65**), perception (**30**, **53**, **69**, **74**, **75**, **80**), learning and memory (**8**, **26**, **60**), and problem solving (**55**, **56**). With regard to conditioning studies in particular, a difference in this factor has been shown to modify to a significant degree the salivary (**71–73**) and eyelid (**10**, **27**, **57**, **58**) reflexes, the GSR (**2**, **11**,

21, 63, 87) and EEG (3, 13, 50), reactions to electric shock (31, 42, 66, 76, 85, 86), conditioned discrimination (35–39) and other sensory processes (5, 17, 18, 63, 65).

From this array of studies there are a few which apply either directly or indirectly to the conditions and findings of the experiment reported in this paper. For example, the work of Cook and Harris (11), Mowrer (63) and Baker and Metzner (2) has demonstrated that the appearance or disappearance of the GSR may be determined by the *S*'s knowledge of whether the conditioned stimulus (CS) will or will not be followed by the unconditioned stimulus (UCS). In other words, a change in the *S*'s expectancy or mental set has a critical effect in altering these CRs. But instances of instructional conditioning and extinction [15] have also been reported in connection with several other forms of behavior. For example, Cole (10) in working with the eyelid response found that it could be either conditioned or extinguished as a result of verbal instructions, and Hunter (42) obtained the disinhibition of voluntary finger responses in a similar manner.

In this discussion, the term *central factor* will be used to denote the state of affairs associated with *cognitive structure*. Although this latter term was used earlier in connection with the *S*'s awareness by the end of the conditioning session that the electric shock followed the stimulus word *sword*, it may also apply in a more general sense to indicate the degree of the *S*'s awareness of various other aspects of the situation, such as whether there would be additional shocks after Session I. Differences in the degree of cognitive structure may be either qualitative or quantitative. This difference is illustrated by such statements as "It is all very hazy," or "I see these points clearly, but I am sure there are many of which I am unaware."

The most important determinants of this central factor seemed to be the variations in both the experimental treatments during the conditioning and therapy sessions and in the *S*'s active or passive attitude during these periods. (See the discussion of the conditions of Sessions I and II, p. 261, and footnote 6.)

[15] *Instructional conditioning* is used here to designate the establishment of (or marked increment in) a conditioned response subsequent to and dependent upon some form of instruction. Likewise, *instructional extinction* is used to designate the extinction of (or marked decrement in) a conditioned response subsequent to and dependent upon some form of instruction. For examples of studies demonstrating this phenomenon, see 2, 5, 10, 11, 18, 42, 57, 63 and 64. While such 'instructions' are usually given (with varying degrees of effectiveness) to the *S* by the *E* at the beginning of an experiment, they need not be verbal (63, pp. 63–66) and may even be due to the *S*'s personal interpretation of the situation (57, p. 351). Razran (72) in particular has stressed the point that in conditioning experiments on the human level, precautions must always be taken to control the *S*'s attitude, etc., if reliable CRs are to be obtained. The changes responsible for the modification of the *S*'s reactions are usually spoken of in terms of postural, neuromuscular, or mental set.

One of the clearest discrepancies between the Aware and Unaware groups is seen in the fact that the average GSR for the latter *Ss* was 2.2 times as large as that of the *Ss* in the Aware group during Session I. Since this result cannot be attributed to any systematic differences in the experimental or objective conditions (because there were none), it must then indicate characteristic differences in the reactions of these two groups during the conditioning or stressful situation (see results, *7*, *23*).[16] Moreover, even when the GSRs to *sharp* and to the shock are not considered, the average reactions of the Unaware *Ss* is still 2.2 times as great as that of the other group during Session I. Thus, it seems plausible that those *Ss* who fell into the Unaware classification did so because they were excessively disturbed by the stress imposed during the conditioning session [17] as well as (or perhaps even rather than) that the *Ss* who never learned that the shock followed the word *sword* tended, as a result of this ignorance, to exhibit greater autonomic reactions during Session I.

Further light is shed on the relationship between the physiological and psychological reactions when the conscious experiences of the *Ss* are considered. For instance, several *Ss* in the Aware group mentioned at the close of Session I that they felt mild emotional disturbances whenever they heard or thought of the stimulus words *sharp* or *sword*, while the Unaware *Ss* spoke rather of a generalized feeling of apprehension or anxiety. The question then is why both the autonomic reactions and subjective experiences of the Unaware *Ss* were not focalized on such words as *sharp* and *sword*—even though this pair of words was repeated five times during the list, and the autonomic reactions of this group to these stimuli were substantially larger than those of the Aware *Ss*. A possible explanation is that as a result of an inability to handle or tolerate the imposed stress, the *Ss* who fell into the Unaware classification tended to show excessive reactions to all words in a generalized and indiscriminate manner. Such a response tendency would preclude the development of any contrast or figure-ground effect in which the reinforced stimuli (e.g., *sharp* and *sword*) stood out sufficiently from the others to be recognized as danger signals. This general pattern was found in the present set of data.

Another indication of the difference in the ability of these groups to tolerate the imposed stress is found in the size of their reactions to both the pre-critical word and to the electric shock during Session I

[16] This method of notation will be used to designate the appropriate sections of the Results which are referred to in this discussion.

[17] This point of view was similarly expressed by Anderson (1, p. 340) in his recent discussion of various interactions between emotional and intellectual or cognitive behavior, where he pointed out that in cases in which the disturbance is too great, "the internal reaction may be so intense that no structuring can occur."

(see Figs. 2, 3, Results, *5*, *6*). While it might not be justified in this case to consider the size of the GSRs to *sharp* as an indication of the degree of conditioned anticipation of the coming shock,[18] there is no question as to the obvious difference in the reactions of these two groups to the electric shock itself. Not only was the average GSR of the Unaware *S*s half again as large as that of the Aware group, but these *S*s also showed a degree of adaptation to the shock during the session which was only about half as great as that of the Aware group (see Fig. 3, Table I, Results, *6*).

To learn, however, that the Unaware group was characterized by both a passive attitude during the situation and a tendency to react excessively to the shock does not inform us as to whether a causal relationship exists between these behavior patterns. On the basis of the present data, it cannot be determined whether (*a*) the excessive disturbance shown by the Unaware group resulted from the tendency of these *S*s to remain passive in the face of the imposed stress and fail to confront the situation in an active manner, or (*b*) whether these *S*s were unable to tolerate or adjust to the stress, and their passivity was a defense mechanism which served as a buffer to protect or shield them from experiencing an excessive degree of disturbance. But in either (or both) of these cases, the assumption is untenable that the mere lack of information regarding the nature and occurrence of the disturbing elements involved in a stressful situation (e.g., the psychology of the ostrich) may insure freedom or protection from the effects of those elements. On the contrary, the *S*s who were most aware of the relationships obtaining among these elements showed less disturbance to the imposed stress and a more rapid recovery from its effects.

II. *The Role of the Central and Peripheral Factors (Active Participation).*—That altering the state of affairs in the periphery of the organism may result in a modification of various activities and responses is well established. For example, from studies investigating the effect of variations in the degree of exteroceptive or proprioceptive stimulation reaching the higher centers we find such changes as decreased reaction time (**81**), enhanced discrimination (**32, 33, 46, 52**), increased rate of electrical responses to sound as a result of visual stimulation (**24**), increased blocking of the occipital alpha rhythm or EEG (**13, 43, 83**), and a modification of certain forms of 'mental activity' (e.g., **12, 60**).

[18] Since the average GSR of the Unaware group was 2.2 times as large as that of the Aware group for all words (whether or not they were directly associated with the shock) it is entirely possible that if one selected any word at random from the end of the list, he would obtain a difference such as the one reported for *sharp*. This is not the case with regard to the differences between the reactions of the *E*-shock and *S*-shock groups. See also Results, *7*, *23*.

The studies in which *both* the central and peripheral factors were involved, however, are of more direct interest in connection with the present experiment. *In such instances where the S is required to participate in the conditioning procedure, both the central factor* (the mental set or decision to make the given response) *and the peripheral factor* (the effect of the response) *are involved.* Thus, to mention 'the role of the peripheral factor' in relation to such experiments necessarily implies the involvement of the central factor as well. Relevant experiments have been concerned with such responses as the cardiovascular (**51, 61, 62**) and pupillary (**9, 41**) reflexes, the EEG (**3, 44, 45, 50, 79**), the GSR (**34**) and the autokinetic phenomenon (**30**), movements of the ear (**4**) and arm (**15**), and the eyelid (**10, 59, 67, 68**) and patellar (**77, 78**) reflexes.

In the present study, it was repeatedly observed that differences in the pattern of the *S*s' autonomic reactions corresponded to variations in the extent to which the central and peripheral factors were involved together in the various experimental procedures. This is particularly true with regard to both the general and specific reactions of the active (*S*-shock) and passive (*E*-shock) groups.[19] More specifically, during Session I, the *E*-shock *S*s not only manifested a significantly larger GSR to the electric shock throughout the conditioning session, but also showed little if any adaptation to this stimulus by the end of the period. The *S*s who voluntarily shocked themselves, however, displayed a more moderate reaction to the initial shocks, with a marked tendency toward a decrease in the disturbance as the period progressed (see Fig. 3, Results, *3*). A similar pattern, it will be recalled, appeared between the reactions of the Aware and Unaware groups. The common characteristic of the one set of *S*s (*S*-shock, Aware) is that they both took an active role during this session, while the other *S*s (*E*-shock, Unaware) tended to remain passive in the face of the imposed stress.

Likewise, the *E*-shock group displayed a significantly greater reaction to the word *sharp* during Session I than did the *S*-shock *S*s (Results, *2*). This difference cannot be discounted as an artifact resulting from the general size of the GSRs to all words, as was possibly the case with the Aware-Unaware *S*s (see Results, *7*, footnote 18). In reference to similar instances, Hilgard and Marquis (**40**, p. 143) have cited evidence to the effect that the magnitude of the unconditioned response should be a direct determiner of the strength of the conditioned response which develops. This difference between

[19] Note that the *S*-shock *S*s knew (central) that the shock would be introduced by the light and would occur when they responded by pressing the plunger down far enough to ring the bell (peripheral). See also the distinctions made between these groups in the discussion of the experimental conditions, p. 261.

the *E*-shock and *S*-shock groups, furthermore, cannot be attributed to any 'conscious' association between the word *sharp* and the shock, since five of the *E*-shock *S*s did not even know that the shock followed *sword*. Thus the pattern of reactions displayed by the *E*-shock group appears to be an instance of conditioning in which the organism responded appropriately to the stimulus word, even though the *S*s did not 'consciously' recognize it as a danger signal.[20] But the lack of a 'logical reason' for showing signs of disturbance whenever they heard the pre-critical word did not prevent the autonomic reaction.

This finding, then, raises the question, Is there any basis for assuming the occurrence of 'unconscious emotions' in the *S*s participating in this study? The answer rests on the definition of the term. If (*a*) we define 'unconscious emotion' as a pattern of observable reactions of an individual (of which *he* is unaware) to stimuli which are known to be associated with objects or events which do elicit 'conscious emotion' of which he *is* able to report, and if (*b*) the observed reactions (of which he is unaware) are not qualitatively different from those of individuals who, under similar circumstances, do report having experienced affective disturbances, then the present data indicate the presence of such 'unconscious emotions.'

During Sessions II and III, the most meaningful differences between the responses of the shock groups is in terms of the extinction rates of their respective GSRs to the stimulus words *sharp* and *sword*. From Figs. 2 and 3, it can readily be seen that during both Sessions II and III, the passive (*E*-shock) *S*s displayed a greater average decrement in the size of their GSRs to both *sharp* and *sword* than did the active (*S*-shock) *S*s in every instance (see Results, *8*, *9*, *16*, *17*).[21]

There are two possible explanations which might account for this difference between the extinction rates of these two groups. It may be said to result from the fact that (*a*) the GSRs of the *E*-shock group were much larger during Session I, and therefore decreased more rapidly when the reinforcing agent was removed, or that (*b*) the finger response of the *S*-shock *S*s acted as a conditioned stimulus which served to elicit the GSR during the non-reinforced trials.

Actually, it is not necessary to choose between these two positions, since both are supported by the data. As to the first hypothesis,

[20] Diven (16) reported a similar result, which he called 'primary displacement.' However, he did not specify the difference between the size of the average response to the pre-critical word and the average response to all words in the list. See also footnote 18.

In regard to these reactions to the pre-critical word *sharp*, Estes and Skinner (20, p. 400) have defined *anxiety* as "an emotional state arising in response to some current stimulus which in the past has been followed by a disturbing stimulus." See also footnote 7, *b*.

[21] This effect of active participation is also indicated by the fact that the extinction rates of the Aware and Unaware groups do not cross each other during Session III, but tend to remain parallel.

the fact that the extinction rates of the aware and shock groups during Session II are not characteristically different and that the decrease during Session II is proportional to the magnitude of the reaction during Session I indicates that the size of these GSRs during Session I were provisionally maintained by the UCS (shock). The second hypothesis is concerned with the stability of the CRs rather than with what appears to be a temporarily heightened level of excitation. Two lines of evidence support this second position. First, the findings of Session III can only be explained by the latter principle, since although the *E*-shock *S*s showed slightly larger GSRs to both *sharp* and *sword* at the beginning of the session, their reactions were decidedly smaller by the end of that period (see Figs. 2, 3, Results, *17, 18*). Second, it has frequently been demonstrated by other investigators that the participation of the *S* in conjunction with the CS and UCS is of critical importance in the establishment and maintenance of stable conditioned responses (e.g., **4, 34, 41, 45, 51, 61, 62, 79**).

In the present experiment, there were only two clear-cut instances in which the existence of the possible relationship between degrees of active participation and the extent to which the CR tended to persist or be extinguished during the non-reinforced trials could be tested. In the first case (Experimental Extinction therapy, Session II), the passive group showed an average decrement in the reaction to the word *sharp* of 1.0 units, while the active *S*s showed an average *increment* of .7 units at the end of the non-reinforced trials. The active group also showed a smaller decrement in response to *sword* during this period. The second group (Rest therapy, Session III) differed from the former *S*s in that they were tested some 30 min. after the conditioning session rather than immediately following it. Here we find a similar trend, in which the passive *S*s displayed an average decrement of 2.2 and 2.7 units in response to the words *sharp* and *sword* respectively, while the active *S*s again showed an *increment* of .4 and .1 units in response to these stimulus words at the end of the extinction series.[22]

There are also findings which indicate that the central factor alone (e.g., degree of information) was effective in modifying the extinction rates of these *S*s to the stimulus words. First, however, it should be noted that the relationship between the word *sword* and the shock is much more apparent than that between the more removed word *sharp* and the shock. Thus, if a person was aware that *sword* (but not *sharp*) was associated with the shock, we would expect on the

[22] It seems preferable to think of these differences in terms of some form of 'central reinforcement' in view of the fact that of the active subjects, only those given C-I therapy (and these were told of the *sharp-sword*-shock sequence, and that they would not be shocked again) did not tend to show an increased GSR at the end of the extinction trials, while no such trend was apparent for the passive *S*s.

basis of previous studies (e.g., **2, 11, 63**) that differences would appear in the extinction rates of the GSRs to these two words. This assumption is substantiated by the fact that during Session III, the differences between the active and passive groups in the extinction of their GSRs to *sharp* was significant beyond the .01 level, but for *sword* it fell at about the .33 level (see Results, *17*, *18*, and also *12*, *13*). A similar trend was found to exist between the reactions of the Aware and Unaware groups (see Results, *21*, *22*). Differently stated, the extent to which the effect of active participation served to modify the reactions of the active and passive groups is more clearly seen in their reactions to the word *sharp*, since in the case of the word *sword*, the influence of the added central factor served to conceal this difference.

Differences in the reaction of the shock groups were manifest in the general degree (*level*) of autonomic activity as well as in responses to the specific stimulus words. That is, the passive (*E*-shock) group showed significantly more disturbance as a result of the imposed stress during the conditioning session than did the active (*S*-shock) *S*s (see Results, *1*). Further indication of the importance of active participation (as opposed to the mere awareness of when the shock would come) is evidenced by the fact that there was no clear-cut difference between the Aware and Unaware groups on this measure of generalized disturbance (see Results, *4*).[23]

During the therapy session also, differences between the autonomic reactions of the active and passive groups continued to be manifest. In this case, the same therapies were, on the average, over twice as effective in checking the induced disturbance in the *S*s who had taken an active role during the conditioning session (see Results, *8*).[24] The size of this discrepancy is at once apparent when a comparison is made between the reactions of these groups in connection with these three procedures (see Fig. 4). Furthermore, the assumption that the differential patterns of the *E*-shock and *S*-shock groups during Session II is due merely to a perseveration of the disturbance initiated during the conditioning session is precluded by the fact that marked

[23] The conclusiveness of this latter finding is limited, however, since those *S*s who did induce the relationship between *sword* and the shock were usually unaware of this association for the first two or three shocks. In connection with this general point, some additional experiments were run in which the *S*s were overtly passive (i.e., they made no voluntary response) but were told that the shock would come one second after the light appeared. Thus, these *S*s were provided with the same degree of cognitive structure as the *S*-shock group, but remained passive as had the *E*-shock *S*s. The average increment in the level of autonomic activity for these *S*s fell between the characteristic trends of the *E*-shock and *S*-shock groups. This would indicate that *more* than a difference in the central factor is required to account for this statistically significant difference between the reactions of the active and passive groups.

[24] That the role of the central factor alone was of some importance in this connection is indicated by a similar, though more moderate difference between the corresponding reactions of the Aware and Unaware groups. See also Results *14*.

differences appear between the active (Experimental Extinction and Catharsis Information) therapies, while no such difference occurred between the shock groups in the case of the passive (Rest) treatment. Rather it indicates that the increment in this measure of autonomic activity (e.g., as shown by the relative heights of the columns in Fig. 4) is a function of the interacting effects of the shock and therapy conditions.

It is likewise evident that when the conditions of Session I (e.g., shock and awareness) are allowed for, the three therapies clearly differentiated themselves in terms of their effectiveness during Session II (see Figs. 4, 5, Results, *11*). The degree of efficiency characterizing these therapies is roughly proportional to (*a*) the extent to which the particular group was required to re-confront the previous situation (behaviorally as in Experimental Extinction, or ideationally as in Catharsis Information), and (*b*) the amount of information which the *S*s in these groups received regarding such matters as whether additional shocks should be expected (implicitely as in Experimental Extinction or explicitely as in Catharsis Information).[25] For example, the therapy in which these two conditions were most operative (Catharsis Information) was significantly more effective than the one (Rest) in which they were least present, if at all. The procedure in which the *S*s went through the motions of Session I but received no shocks (Experimental Extinction) was somewhat more effective than Rest therapy, and so fell into an intermediate position.

Thus, from the data presented in this paper, we see that the peripheral factor interacted with the central factor in determining the magnitude and persistence of both the general and specific autonomic reactions of the *S*s. Furthermore, it appears that the central factor was more important in determining the general level of autonomic activity, while peripheral involvement played the primary role in modifying the reactions to specific elements in the situation (see Results, *25*).

III. *Integration of the Central and Peripheral Factors.*—Among the references to experiments demonstrating the critical importance of active participation in the conditioning procedure, several studies were mentioned in which the *S*s became able to elicit at will several responses which were previously evoked only by the presentation of an appropriate external UCS. These include movements of the ear (**4**), the cardiovascular (**51, 61, 62**) and pupillary (**41**) reflexes, the blocking of the occipital alpha rhythm (**45, 79**) and the GSR (**34**). In the establishment of this control, several common and requisite conditions were found among the different techniques or procedures.

[25] This factor of information is of prime importance, since the occurrence of the shock incited the disturbance and was singularly dreaded by all *S*s. See also footnote 3.

More specifically, it was always necessary (*a*) that the *S* make a voluntary (and preferably overt) response in conjunction with the original CS and UCS (e.g., squeezing a dynamometer), and (*b*) that this voluntary response in turn come to serve as the reinforcing agent (as a secondary or pseudo-UCS) for subsequent and more covert self-initiated responses (e.g., vocal and later sub-vocal repetition of the word 'contract'). As a result of this procedure, (*c*) the given response could be elicited 'voluntarily' by means of the covert, self-initiated signals. In other words, during the establishment of such CRs the central factor came to assume a more and more dominant or self-sufficient role, so that as the necessary agents or cues became internalized, the particular response could be called forth independently of the previous external stimulus or the overt reinforcing response. In this final stage, there were apparently no signs of extinction. The occurrence of this phenomenon necessitates the inference of a change in the central state of affairs which corresponds to and parallels the establishment of this voluntary control. This change will be referred to as the development of *central integration*.[26]

Although no attempt was made to condition the active (*S*-shock) group to the extent that their GSRs could be called forth voluntarily, there exist, nevertheless, certain communalities among the experimental conditions and results of the present study and those of the above investigations. For example, the *S*-shock *S*s made an active, voluntary response in conjunction with the CS and UCS, and subsequently showed little if any extinction of their GSRs to the specific stimuli during the non-reinforced trials. (This was not the case with the passive *E*-shock *S*s.) It might be said, then, that an experiment in which voluntary control is established over a previously non-voluntary response exemplifies a limiting case in the modification of behavior patterns, and that certain conditions in the present experiment tend to approach this state of affairs.

Can it be maintained, however, that the various conditions involved in the voluntary self-administration of the shock during the conditioning session resulted in an altered state of central integration which, in turn, was influential in determining the *S*s' autonomic reactions? This position is tenable on the grounds that such patterns

[26] From the evidence supporting the postulation of such a concept as 'central integration,' Hudgins (41, p. 45) pointed out that in developing voluntary control over the pupillary reflex he was working with a mechanism which does not possess afferent nerve endings. Thus, *some* central change was essential if this response was to be elicited in the absence of the normally adequate stimulus (a change in illumination). Also, from the work in intra-neural conditioning, Loucks (54) reported that electrical stimulation of the motor area could serve effectively as a CS, but not as the UCS. However, Brogden and Gantt (7) found that the electrical stimulation of the neocerebellum does serve as an UCS, and that CRs were obtained as readily by this means as though the shock had been applied to the animal's leg. That is, no learning occurred in the former case, which neither allowed for nor required the development of central integration.

have been established in connection with the same or similar mechanisms primarily under the domination of the autonomic nervous system (e.g., the GSR, pupillary and cardiovascular reflexes). Furthermore, the difference between the reaction patterns of the active (*S*-shock) and passive (*E*-shock) groups during both the conditioning and subsequent sessions cannot be adequately accounted for unless the reinforcing effect of the self-initiated activity is considered. That is, it was repeatedly found that the results of the present study require the position that active participation (and this amounts to voluntary behavior) during the experimental situation played a critical role in determining certain characteristics of the general and specific patterns of autonomic activity in the *S*s who took part in this investigation.

Summary

The experiment was designed to study some of the factors involved in the establishment and modification of autonomic reactions of normal adult human *S*'s to stress induced by strong electric shock. Measures of palmar sweating were used to indicate the *S*s' general level of autonomic activity and reactions to specific aspects of the situation. The test was composed of three periods: I, the conditioning or stressful session, during which the *S*'s were asked to give chained associations to each of 42 stimulus words. They were always (and only) shocked between 10 and 12 sec. after the stimulus word *sword*, which recurred five times during the list; II, the therapy session, in which one of three experimental procedures was employed to alleviate the general disturbance and extinguish the specific reactions initiated during the first session; and finally, III, a test period to measure the relative effectiveness of the therapies. All three sessions were between 30 and 40 min. in length for all *S*s.

Factorial design was used so that the effects attributable to differences in the administration of the shock and among the therapies could be determined. In the first case, nine *S*s were shocked by the *E* without any explicit warning (*E*-shock), while another nine *S*s shocked themselves whenever a light appeared on the table before them (*S*-shock). In the second case, six *S*s were given no active treatment at all (Rest therapy), six underwent a duplication of the first session, except that no shock was administered (Experimental Extinction therapy), and another six *S*s were given an opportunity to express openly and frankly any anger, fear, resentment, etc. and were allowed to ask any questions regarding various aspects of the experiment, such as its purpose, the nature of Session III, or whether there would be additional shocks (Catharsis-Information therapy). The *S*s were also distinguished on the basis of whether they had

induced the fact that the shock always followed the critical word *sword* during Session I (Aware), or were not conscious of this relationship (Unaware).

The results of this study justify the following major conclusions.

1. Those *S*s who were shocked by *E* during Session I manifested a greater autonomic reaction to the shock, less adaptation to the shock, a greater degree of 'unconscious' conditioned anticipation of the shock, and a greater increase in general level of autonomic activity during this session than did those *S*s who voluntarily shocked themselves.

2. Similarly, the *S*s in the Unaware group tended to show a greater reaction to the shock, less adaptation to the shock, and larger GSRs during the conditioning session.

3. Rest therapy was the least, Experimental Extinction therapy somewhat more, and Catharsis-Information therapy the most effective procedure in alleviating the general level of increased autonomic activity initiated during the first session.

4. In general, the therapies were more effective for those *S*s who had shocked themselves during Session I than for those in the passive *E*-shock group, and more effective for the Aware than for the Unaware *S*s.

5. Those therapies which were most effective in checking the general level of disturbance tended to be less effective in extinguishing responses to the specific aspects of the situation, and vice versa.

6. The *S*-shock *S*s, who made a voluntary response in conjunction with the CS (light) and UCS (shock) during Session I and continued to make this response during the non-reinforced trials, showed little if any extinction of their conditioned GSRs to the words closely associated with the shock. This was not the case for the passive *E*-shock *S*s.

7. In general, those individuals who knew most about the conditions involved in the situation and who took an active attitude or role in facing this experience consistently showed less disturbance on all measures of autonomic reactivity during the stressful and therapy sessions.

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EXPERIMENTAL STUDIES OF THE JUDGMENTAL THEORY OF FEELING: V. THE INFLUENCE OF SET UPON THE AFFECTIVE VALUES OF COLORS

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The following experiment was performed with two purposes in view, namely, to verify with color stimuli the relationship previously found with verbal materials between learned reactions and affective judgments, and secondly to obtain data which would test the major hypothesis behind the previous investigations, that positive and negative reactions established during learning are the determinants of the following changes in affective value.

Reports of the previous investigations include a complete orientation to this experiment (1). The details of the present experiment were as nearly as possible like those of the previous studies. In case the reader is puzzled about any of the details of procedure not mentioned in this report, he will probably find the answer to his question in these previous reports.

PROCEDURE

The 14 *S*s of the Test Group (7 men and 7 women) were students in one of the writer's advanced courses. They were accustomed to being *S* in laboratory experiments, although they had had no experience with affective experimentation. They were not aware of the nature of the problem of the present study. The materials or objects judged were eight Hering colors: R, Y, G, B, O, P, YG, and BG. Strips of the colored papers, 3/8 in. × 7/8 in., were presented on a white background. Each *S* was individually put through the following three stages of the experiment, consecutive stages being separated by an interval of a week.

(1) The purpose of the first stage was to get affective judgments of the colors before learning. (*a*) First, the *S* was required to name the eight colors. Each color was centered on a 4 in. × 6 in. filing card. *S* turned them one at a time and named the color. (*b*) In the second place, *S* made paired comparison judgments of the colors. The 28 pairs were pasted each on a separate filing card, the strips separated by 1/2 in., with the name of each color printed below it. An empirically derived order of presentation was used which balanced the place, or space, factor and which separated the consecutive appearances of the same color. The stack of cards was placed on the table before the *S*, and the following instructions read by *E*.

> "Now you are to indicate your preference for one member of a series of color-pairs. On each card in this stack two strips of color are pasted. You are to turn the cards slowly and name which of the two you prefer. You will find the name of each color printed below it.
>
> "In doing this the experimenter is not only interested in your particular color preferences; he is also interested in just *how* you determine your preferences between two members of a pair. Therefore, while you are judging the colors, give some attention to the process of arriving at a judgment, so that in the end you can describe this process to the experimenter. Should you develop any ideas about this judgment process before the end, you can dictate them to the experimenter at the time, without waiting to the end."

(*c*) A 12 min. interval was spent rating the affective values of 32 pictures on a nine-point rating scale. The purpose of this part of the experiment was to fill a 'rest' period between two paired comparisons of the colors. When necessary the time interval was padded with conversation about the pictures. (*d*) Lastly, the *S* made a second series of paired comparison judgments of the eight colors. The cards were presented in the same order as before, with right-left inversion of the position of the members of each pair. This time *E* simply requested the *S* to "judge these again."

(2) The second stage of the experiment was the learning problem. Before *S* began learning he was handed the following instructions to read.

> "When the memory drum before you starts, pairs of colors will appear in the small window. Each pair of colors will remain in the window for 3 seconds. For each pair of colors, you are to speak aloud the *name* of one of the colors. Now, *one* of the colors of each pair will always be the 'correct' one to name. Naming the other color will be counted an error. Your problem is to learn to name only the correct member of each pair in the list—and to do this in as few exposures of the list as possible.
>
> "For the first exposure of the list of pairs, you will of course have to guess. When you name the wrong color the bell at your left will ring; when you name the right color, the bell will not ring. Thus, when you go through the entire list without error, the bell will not ring at all. You have finished when you have gone through the list 3 times perfectly.
>
> "When you make an error of calling a color by the wrong name, for example, calling a blue-green 'blue,' the experimenter will correct you. This will be counted an error."

The color-pairs, without the names printed below, were presented in the same order used in the paired comparison judgments. Only the one order was used.

Each pair remained in the window for six sec. The time interval between appearance of a pair and ringing of the bell, in case of error, was 4½ sec. This interval was constant regardless of whether *S* had remained silent or had responded falsely. The time between successive exposures of the list was 12 sec.

Although the pairs were presented in the same order for all *S*s, the particular members to be named varied from *S* to *S*. The colors to be named for each pair for any *S* were determined in the following manner. The eight colors were put into a rank order for the *S* in terms of the number of preferences each had received in his two paired comparisons. The original ranks (O. Rs.) of the colors will be symbolized in this paper by the numbers 1 through 8. Color 1 received the most, color 8 the least, number of preferences. A 'learning order' was derived by simply sliding the bottom four colors above the top four, thusly, 5—6—7—8—1—2—3—4. Color 5 was to be named for all of its seven appearances on the drum; color 6 was to be named for all appearances except that with color 5; and so on down to color 4, which was to be named for none of its appearances.

The usual learning records of trials and errors per trial were kept.

(3) The purpose of the third and last experimental sitting was to get *S*'s affective judgments of the colors after learning. The procedure here was the same as in (1) without the preliminary naming of the eight colors and without the detailed instructions.

Seven men and seven women from an introductory class were used in the Control Group. Their ages ranged, as did those of the Test Group, from 20 to 30 years. Sex and age are the only two variables the writer can conceive of as possibly being systematically related to the responses under investigation. The control procedure was divided into three stages, or sittings, separated by week intervals. (1) and (3) were identical with the same stages of the Test Group. (2) was a condition involving only the 32 pictures and is considered irrelevant to the main experiment.

Results

I

The learning problem established a consistently positive or negative reaction to only two colors per *S*. These colors were, for each *S*, those which stood in the O. Rs. of 5, which required a consistently positive reaction, and 4, which required a consistently negative reac-

tion. The colors of other O. Rs. required degrees of positive and negative reactions which varied by steps of 1/7ths. As a result the mean-total-positive-responses actually made during learning, for the whole group, varied directly with the required degrees of positive responses. This is evidenced in the second row of figures of Table IX.

If it is assumed that the strengths of the positive reaction tendencies, resulting from the learning problem, varied, from color to color, directly with the frequency of positive, and inversely with the frequency of negative, reactions, then these strengths should decrease from color of O. R. 5 to the color of O. R. 4. If this is true, then from the major hypothesis that affective judgments are surrogates of *S*'s existing reaction tendencies, it would follow that the paired comparison judgments after learning, as compared with those before, should show an enhancement of affective value which would vary directly with the number of positive responses in learning. Specifically, the amount of increment in value should be greatest for the first and progressively decrease to the last of the colors of O. Rs. in this order: 5–6–7–8–1–2–3–4. (For the sake of simplicity, a decrement will be considered a negative increment in this exposition.) The increment in affective value is to be measured by comparison of corresponding changes of judgment in the Test and Control Groups.

Exhaustive comparison of the judgmental data for the Whole Test Group with those of the Whole Control Group disclosed no reliable evidence of the expected trend in judgment changes, although most of the methods of comparison favored the hypothesis. The mean percent of reversals on decision pairs, for which the U member was positive in learning, illustrates very well the sort of difference found. By a 'reversal' is meant a switching of preference on the second judgmental sitting to the member not preferred on the first judgmental sitting, two weeks earlier. A 'decision' pair is one for which *S*'s two original paired comparisons were in agreement. To be 'positive' in learning means that the color was the member of the pair which *S* was required to name in the learning problem. The percent of such reversals was determined for each *S* in the Test Group. A similar percent for each *S* in the Control Group was obtained by counting the number of reversals for decision pairs which *would have had* the U member positive if there had been an interpolated learning problem. The mean percent for the Test Group was 13.9 ± 5.6 (σ_m) and for the Control Group, 7.5 ± 2.3. The difference (D) is favorable to the hypothesis, but there is a probability (P) of almost 0.2 that it could have occurred by chance alone. (All estimates of significance and reliability, unless otherwise stated, were obtained by the use of Fisher's *t*-test.)

The judgment records for individual *S*s in the Test Group show

wide individual differences in preference changes after learning. Some *S*s show practically no change; others show changes opposed to the hypothetically expected ones; and others show the expected changes. Examination of the *S*s' verbal reports, which were taken in the first experimental sitting, yielded evidence of a bi-modality of *sets* which was found to explain, in part at least, the individual differences in preference changes.

For the most part the *S*s were very brief and fairly positive in their explanations of their paired comparison preferences. These explanations were recorded by *E* in a condensed form of *S*'s own words. Each *S*'s explanation is given below, in words of the original record.

Verbal Reports

A—Certain colors I definitely disliked, and would never choose them. Preferences more absolute than relative. There was no difficulty. The main factor is the clothes I look good in. Some colors I prefer always, but in the mid-range I vary.

B—I definitely dislike any Y—through associations. I like Rs and tints. I like all Bs.

C—My preferences are colors I like in clothes. I just dislike O. I prefer softer colors.

D—At first I chose on the basis of the color itself. Some I like and can wear; others I don't like at all. Later, I chose on the basis of contrast—one color would be enhanced by being next to another.

E—I found myself choosing softer colors. I don't like bright, intense colors. I just dislike R and G.

F—I like colors I can wear, and that go with my coloring. Certain colors I just don't like. It was easy to judge. Judgments were spontaneous.

G—Some colors I wear—I just bought a YG dress and like it. My basis was already established likes and dislikes.

H—I like colors that I can clearly name, and also the brighter and more definite of two colors.

I—I usually picked the lighter of two. At first I tended to choose the color on the left. Just prefer G as a color—and I chose it unless it clashed with the other. Combination of two colors had an influence: when the two clashed, for some reason, one of the two would appear ess unpleasant.

J—I preferred the one that stood out on the card—contrast with background.

K—The way they looked like they would feel. Vague associations which I could not identify —they suggest something else but I am not aware of what it is.

L—I prefer the darker colors to the pale. I have a definite dislike for P. Think I prefer nature colors.

M—The more striking vividness—the one that arouses tactual and thermal associations. Childhood memories were thought of. Associations with previous color experiences. Ease of perception on the card. At the end I was aware of an inner rank-order and it became stereotyped. I felt forced into the judgments—many were arbitrary. Three things were important: (1) visibility, (2) vividness, and (3) richness of associations.

N—At first, it was according to what I would like in a car or some possession. Later I didn't like dull shades. I tried to be consistent. It was easy to do—without trying.

*S*s *A* through *G* were women; *H* through *N* were men.

Identification of the two sets under which the *S*s observed and judged the colors was based on two factors: (1) The evident references in the reports to two kinds of referents, namely, experiential or meaningful (clothes, already established likes and dislikes) and perceptual reactions to the particular color object (brilliance, contrast with background). Reports of the majority of *S*s seem clearly

to favor one or the other of these two types of referents. (2) The second basis of identification was the report of Goldstein (**2**) that two types of sets operate in perceptual reactions of both normal and pathological *S*s, sets which he labels 'concrete' and 'abstract.'

These two are identified herein as the perceptual set and the conceptual set. The first is a disposition which centers attention on the particular object being judged and which selects for conscious attending perceptual features of the object. The second centers attention on a generalized object (concept) for which the particular stimulus serves merely as a symbol. For example, the R strip was judged by the *S* of the first set as a particular red object; by the *S* of the second set the judgment was really one of redness in general, or of redness for some special purpose.

In classifying the *S*s as observing predominantly under one or the other of these sets the following two groups of specific criteria were used. (1) References to perceptual features of the particular color, such as contrast, brightness, saturation, identifiability, were taken as evidence of the perceptual set. (2) References to definitely established likes and dislikes, treatment of colors as stereotypes, and references to use of color (e.g., in clothes), were taken as evidences of a conceptual set. The majority of *S*s were easily typed as observing under one or the other set. A few were doubtful but were typed in terms of which set seemed, in the opinion of the writer, to predominate. *S*s *E*, *H*, *I*, *J*, *K*, and *M* were classed in the perceptual set group; *A*, *B*, *C*, *D*, *F*, *G*, *L*, *N* were classed in the conceptual set group. Five of the six *S*s in the first group were men; only two of the eight *S*s in the second group were men.

It was expected that the perceptual set group would show a greater effect of the learning problem on affective judgments. The reasons for this expectation are the following. (1) The two sets determine judgmental reactions of different degrees of learning. The judgments of the perceptual set are reactions to the immediate sense impressions aroused by the physical stimulus, and are only in a very limited sense learned reactions at all. The judgments of the conceptual set, on the other hand, are reactions to abstractions from the psychological object, or concept, aroused by the physical stimulus, and these abstractions are really products of past experience. (2) The influence of the learning problem on judgments is an interference effect. The reaction tendencies, and the judgments based on them, which operate prior to the learning problem conflict with those required by the learning problem. (3) If these two statements are true, then it is to be expected that the perceptual set group will show a greater change in judgments since it has been demonstrated, by McGeoch (**3**), that retroactive inhibition (an interference phe-

nomenon operationally identical with that of the learning problem in this experiment) varies inversely with degree of learning of the original materials.

The Control Group was similarly divided into a perceptual set and a conceptual set group. The former numbered eight (six of them men); the latter numbered six (one man). Each of these sub-groups of the Control Group is the appropriate 'control' for the corresponding sub-group of the Test Group.

II

Tables I, II, and III present figures which are the outcome of comparisons of judgment changes in the perceptual set sub-group of the Test Group (T_p) with changes in the conceptual set sub-group of the Test Group (T_c), and the comparisons of each with its correspond-

TABLE I

NUMBER OF *Ss* WHOSE PREFERENCES (1) INCREASED AND (2) DECREASED FOR COLORS OF EACH ORIGINAL RANK

(1) *Increased*

Group	1	2	3	4	5	6	7	8
T_p	1	1	1	1	3	4	5	3
C_p	2	3	4	3	1	3	6	4
T_c	1	2	3	5	2	3	3	1
C_c	2	2	2	0	3	2	2	2

(2) *Decreased*

Group	1	2	3	4	5	6	7	8
T_p	2	3	4	5	2	1	1	1
C_p	5	1	3	4	7	5	0	1
T_c	1	2	4	3	2	2	3	0
C_c	1	2	3	3	2	1	2	0

TABLE II

MEAN PERCENT REVERSALS OF DECISION PREFERENCES

	Perceptual Set	Conceptua Set
Test Group	26.7 ± 10.5	4.3 ± 3.5
Control Group	6.6 ± 2.4	8.8 ± 4.5

TABLE III

MEAN PERCENT OF PREFERENCES FOR POSITIVE MEMBER OF INDECISION PAIRS

	Perceptual Set	Conceptual Set
Test Group	81.0 ± 8.4	44.3 ± 13.6
Control Group	57.3 ± 11.1	60.0 ± 15.3

ing sub-group of the Control Group (C_p and C_c). The two crucial comparisons are (1) $T_p - C_p$, and (2) $T_c - C_c$. When the former difference is positive and at least significant, the hypothesis that perceptual set *Ss* show the trend predicted by the major hypothesis is verified. When the latter difference is insignificant, the hypothesis that conceptual set *Ss* show the trend predicted by the major hypothesis is not verified.

Table I shows, for all four sub-groups, the number of *Ss* whose preferences increased and the number whose preferences decreased for colors of each O. R. Inspection of the table shows for T_p a decided piling up of *Ss* whose preferences increased in the O. Rs. 5 to 8 and a piling up of *Ss* whose preferences decreased in O. Rs. 1 to 4. This is the trend predicted by the major hypothesis. It is shown by none of the other three sub-groups. The significance of the differences between these distributions was estimated by the chi-square technique, grouping the units (*Ss*) into the two intervals 1–4. and 5–8. The difference between T_p and C_p was found to be the only one approaching significance (P between 0.10 and 0.05). The difference between T_c and C_c is both small and not favorable to the hypothesis.

The number of *Ss* in each sub-group whose preference changes showed the expected trend was determined. All, or six, in T_p showed the trend; four of the eight *Ss* in C_p, two of the eight *Ss* in T_c, and three of the six *Ss* in C_c, showed the trend.

Table II shows the mean percent of reversals on decision pairs for which the U member was positive. This measure is explained in the first section.

The difference between T_p and C_p approaches significance (P is slightly more than 0.05). The difference between T_c and C_c is of course insignificant.

Table III shows the mean percent of preferences for the positive member of indecision pairs. An 'indecision pair' is one on which the *S*'s two original paired comparisons did not agree. The number of indecision pairs was determined for each *S*, and a count was made of the number of times he stated a preference for the positive member of such pairs after learning. The possible number of preferences was two times the number of indecision pairs. For each *S* the percent was the number of preferences divided by the possible number. Table III presents the means of these percents for T_p and T_c, as well as for the sub-groups of the Control Group, assuming that they were given a similar learning problem.

The difference between T_p and C_p considered alone cannot be counted significant (P is slightly more than 0.10). The difference between T_c and C_c is insignificant.

The number of *Ss* whose percent was greater than 50 (chance) was determined for each sub-group. The number was five for T_p, four for C_p, three for T_c, and three for C_c.

Although each of the two T_p minus C_p differences, that of Table II and that of Table III, when considered alone is not impressive, when considered together they are impressive. The P for the two to occur together is equal to the product of the Ps for each alone, which is small enough to enable one to conclude the presence of a reliable difference.

III

Ss of perceptual set were less self-consistent in their judgments than were *Ss* of conceptual set. Table IV presents means which demonstrate this greater inconsistency of perceptual set *Ss* between the two paired comparisons of one sitting. Table V demonstrates it between the judgments of the two sittings which were separated by a two-week interval.

TABLE IV

MEAN NUMBER OF INDECISION PAIRS ON THE FIRST AND SECOND PAIRED COMPARISONS

	I	II
T_p	4.2 ± 1.1	6.3 ± 1.6
T_c	2.5 ± 0.4	0.9 ± 0.3
C_p	3.1 ± 0.5	3.8 ± 0.6
C_c	2.3 ± 0.7	1.5 ± 0.6

TABLE V

MEAN PERCENT REVERSALS OF JUDGMENT FOR DECISION PAIRS IN WHICH THE P MEMBER WAS POSITIVE

	Perceptual Set	Conceptual Set
Test Group	26.4 ± 9.9	9.4 ± 5.4
Control Group	24.2 ± 4.3	7.2 ± 2.8

Table IV shows for each sub-group the mean indecision pairs on the first and on the second judgmental sitting. The figures show similar differences between perceptual and conceptual sub-groups in both Test and Control. The number of indecision pairs is greater in the perceptual set *Ss* for both sittings. From the first to the second sitting, the number increased in both perceptual set sub-groups and decreased in both conceptual set sub-groups. The difference between T_p and T_c at the second sitting is reliable (P is less than 0.01); the difference between C_p and C_c at the second sitting is significant (P is less than 0.05).

Table V shows the mean percent of reversals on decision pairs for which the P member was positive in learning. Derivation of these means was identical with those of Table II. The difference between

the sub-groups is of the same magnitude and in the same direction for both Test and Control Groups. The difference between T_p and T_c is not significant (P is greater than 0.10); the difference between C_p and C_c is very reliable (P is less than 0.01).

In construction of the learning problem, pairs in which the U color was positive in learning were, on the average, much more widely separated on the affective scale then were pairs in which the P color was positive. This explains the greater inconsistency shown in Table V over that of Table II.

IV

A statement was made above of the hypothesis that the changes in affective judgments, of the sort under investigation, were the effect of interference from the learning, and that this interference is greater for *S*s of perceptual set (and will accordingly result in their judgments showing the expected change more than will those of conceptual set *S*s).

The reasoning behind the hypothesis that the judgment changes are caused by interference from learning is the following. It is assumed that P and U judgments signalize, in the *S*s making them, the presence of positive and negative reaction tendencies of the sort established in any learning experiment. The original judgments establish the presence, and direction, of such tendencies toward the experimental objects. In the learning problem the same objects are presented, and the *S* is required to build up reaction tendencies which for the most part are opposed to those originally present. Thus, there should be conflict of the tendencies already present and those required by learning. It was expected that this conflict, and the resultant change in reaction to the objects when presented out of the learning problem, would be greater for *S*s with a perceptual set than for *S*s with a conceptual set, because, by the nature of the two sets, the former selects little learned reactions and the latter selects highly learned reactions, and it has been demonstrated in studies of retroactive inhibition that poorly learned reaction patterns are more subject to interference than are highly learned ones.

If the present data support the hypothesis that greater conflict occurs in the perceptual set group, they likewise support the hypothesis, the major hypothesis, that reaction tendencies underlie affective judgments.

The data of the Test Group furnish several evidences that more conflict occurred in the perceptual set *S*s than in the conceptual set *S*s.

Since for each *S* the majority of the reactions established in learning were opposed to those already present, *S*s who experienced

conflict should show greater evidence of difficulty in their learning scores. Table VI presents for both sub-groups the mean trials, mean errors, and a mean error-index, E/T (total errors divided by total trials). This error-index was obtained separately for each S, and the means computed. Differences in trials and errors are entirely insignificant. The difference in mean E/T, although insig-

TABLE VI

MEAN TRIALS, ERRORS, AND ERROR-INDEX

	Trials	Errors	E/T
Perceptual Set	23.3±3.3	150.5±22.8	6.38±0.49
Conceptual Set	24.0±1.9	133.5±10.4	5.58±0.15

nificant if considered alone (P is over 0.10), is significant when considered along with the additional evidence of conflict in perceptual set group.

If it is assumed that strength of underlying positive reaction tendency to a color is directly related to the number of preferences it receives, then the colors of different O. Rs. aroused positive reaction tendencies of different strengths, color of O. R. 1 arousing the strongest and color of O. R. 8, the weakest. Now, every color, except that of O. R. 5, appeared at least once in learning when it was the negative member of a pair, and thus was not to be named. If the original reaction tendencies carried over into learning (and conflicted) for the perceptual set *Ss*, and did not for the conceptual set *Ss*, the former should show difficulty in learning the negative reaction to various colors to an extent which would exceed that experienced by the conceptual set *Ss* by an amount in direct proportion to their affective values. Specifically, perceptual set *Ss* should have greater difficulty than conceptual set *Ss* at the upper end of the affective scale (O. Rs. 1–4), and relatively less difficulty, or even absolutely less difficulty, than the conceptual set *Ss* at the lower end (O. Rs. 5–6).

A mean response-error-index was determined for each color, for each *S*. A 'response-error' was the naming of a color when it was not supposed to be named. The index was obtained by dividing the number of such errors by the total number of trials. Now, there were different numbers of pairs, for which response-errors were possible, in the case of different colors. In the case of each *S*, the response-error-index was computed separately for each pair in which a particular color was negative member, and the indexes for that color averaged. The means presented in Table VII are averages of these averages.

TABLE VII

MEAN RESPONSE-ERROR-INDEX FOR COLORS OF VARIOUS ORIGINAL RANKS

	1	2	3	4	6	7	8
Perceptual Set	.334 (±.029)	.186	.218	.224	.182	.238	.173 (±.030)
Conceptual Set	.151 (±.034)	.167	.185	.188	.272	.269	.295 (±.036)

The trend of the differences between the corresponding means in Table VII very decidedly verifies the deduction. The perceptual set means are higher for O. Rs. 1–4, and lower than the conceptual set means for 6–8. The difference between the means for O. R. 1 is reliable (P is less than 0.01). The difference between the means for O. R. 8 is significant (P is less than 0.05).

TABLE VIII

MEAN ERROR-INDEXES FOR PAIRS OF THREE DEGREES OF SEPARATION ON THE AFFECTIVE SCALE

	−7 to −14	−1 to −6	+1 to +6
Perceptual Set	.279±.031	.186±.040	.203±.022
Conceptual Set	.156±.025	.156±.028	.260±.020

The means presented in Table VIII likewise demonstrate more carry-over-into-learning, in the sense defined above, of original reaction tendencies on the part of perceptual set *S*s. These means were derived as follows.

For each *S* the total number of errors (whether of naming or not naming) for each pair was counted, and this number was divided by the *S*'s number of trials, giving an error-index. Then, for each *S*, the 28 pairs were classified according to the number of original preferences with which the positive member exceeded the negative member (obtained by subtracting the number of preferences received by the negative member from the number of preferences received by the positive). Of course, this number was negative for the majority of pairs, since a majority of positive members in learning were the less preferred. For each *S*, mean error-indexes were calculated for three intervals of difference in preference: (1) −7 to −14, pairs in which the negative member was much more preferred than the positive member; (2) −1 to −6, pairs in which the negative member was more preferred, but not to such a great extent as in (1); and (3) +1 to +6, pairs in which the positive member was more preferred. These means were averaged for the three intervals, giving the means in Table VIII.

If the original reaction tendencies carry over into learning to a greater extent for perceptual set *Ss*, they should experience relatively greater (relative to conceptual set *Ss*) difficulty with pairs classed in (1) and (2), and relatively less difficulty with those classed in (3).

This is the significance of the means in the table. Mean error-index is greater for perceptual set *Ss* in classes −7 to −14 and in −1 to −6; and less for perceptual set *Ss* in class +1 to +6. The difference for class −7 to −14 is a reliable one (*P* is less than 0.02).

V

In this and preceding reports, by the same writer, on the same general problem, the assumption has been made that the determinants of the demonstrated changes in affective values have been the positive and negative reactions established to the experimental objects in the learning situation. Heretofore no analysis of the learning records has been presented to substantiate this assumption. It is the purpose of this section to present the results of an analysis of the learning records of the *Ss* of the perceptual set group, which favors the assumption.

This assumption, or hypothesis, may be stated specifically as follows. The strengths of positive reaction tendencies attached to objects in learning vary in direct proportion with the frequency of occurrence of positive reactions; the degree of increase in frequency of *P* judgments for the objects is directly related to the strengths of the newly attached positive reaction tendencies; and hence increase in *P* judgments is directly related to the frequency of positive reactions in learning.

TABLE IX

TOTAL CHANGES IN PREFERENCES, MEAN RESPONSE-INDEXES, AND MEAN ERROR-INDEXES

	1	2	3	4	5	6	7	8
Σ Changes	−7	−4	−13	−22	0	+16	+13	+17
M R-Index	3.82	2.52	1.92	1.57	5.62	4.82	4.15	3.57
M E-Index	1.88	1.35	1.53	1.57	1.38	1.53	1.80	1.47

The first row of Table IX presents the total changes in judgment for *Ss* of the perceptual set group, for each O. R. The second row presents a mean total response-index for colors of each O. R. These means were obtained as follows. The number of positive responses, i.e. of naming the color, whether correctly or incorrectly, was counted for each color, for each *S*. These numbers were then divided by *S*'s number of trials. The table means are the means of these quo-

tients. That frequency of naming-response tends to vary directly with degree of increase of affective preference is clearly shown.

The third row of this table presents results which favor the hypothesis in question in another manner, namely, by demonstrating the implausibility of the chief conceivable, alternative hypothesis. This alternative hypothesis is that the affective changes were caused by errors made in learning. If frequency of errors were responsible for the judgment changes, their frequency of occurrence should vary inversely with increase in frequency of preference judgments. The mean total error-indexes, of Table IX, were calculated as follows. For each *S*, the number of errors, whether of positive or negative response, per color was counted. (Notice that this involved counting each of *S*'s erroneous responses twice, as a wrong positive response to one member of a pair was at the same time a wrong negative response to the other member.) These numbers were divided by the *S*'s number of trials. The table means are averages of these quotients. Since these means show no apparent tendency to vary inversely with affective increase, this alternative, error, hypothesis fails of verification.

Means from the records of the perceptual set group only are presented, because this group showed the effect under investigation. Comparable means for the conceptual set group are in almost perfcet agreement with those shown in Table IX.

Summary

A test group gave affective judgments of eight colors, and a week later solved a learning problem in which they were required to make positive responses to the colors, the problem requiring different frequencies of positive responses to different colors. A week after learning, the affective judgments were repeated. A control group judged the colors on two occasions separated by two weeks, without the interpolated learning.

Results showed that *S*s of the test group who observed with a perceptual (concrete) set changed their judgments as expected, namely, by increasing the number of preferences in proportion to the number of positive responses in learning. *S*s who observed with a conceptual (abstract) set failed to show the expected change. This difference in the learning effect for *S*s of the two sets was demonstrated in two ways. (1) By a reliable shift of preferences for *S*s of the perceptual set in favor of colors which were positive in learning, a shift which was not evident in the judgments of conceptual set *S*s. (2) By evidence of greater conflict between affective values and learning in the case of the former than in the latter.

Analysis of the learning records reveals that the shift in affective value is related to the relative frequency of positive responses in learning and not to the relative frequency of errors made.

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MEDIATED GENERALIZATION AND THE INTERPRETATION OF VERBAL BEHAVIOR: V. 'FREE ASSOCIATION' AS RELATED TO DIFFERENCES IN PROFESSIONAL TRAINING[1]

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In previous papers of this series, direct and indirect, or mediated, types of generalization were theoretically discussed (**3**) and experimentally demonstrated along various gradients (**8, 4**). The development of mediated generalization in an everyday-life situation was also experimentally investigated (**9**). In the present paper, an attempt will be made to study the relationship between professional training and the type of verbal response obtained in the 'free association' experiment. Although mediated generalization *per se* is not necessarily involved in such associations, the empirical demonstration of verbal associations along a dimension established by professional training would appear to indicate a definite possibility of the operation of mediated generalization along 'professional' gradients. The present study is thus more 'general' than previous studies in this series: in the earlier experiments the investigators controlled the formation of the associations (**8, 4**) or studied associations known to have been formed in a given classroom situation (**9**), whereas in the present study we are concerned with associations formed in a general curriculum of professional training.

The present experiment may also be regarded as an effort to throw light upon the type of stimulational factors *responsible for* the verbal associations. It is a curious fact that practically none of the numerous studies on 'free association' have directly attacked this basic psychological problem. No attempt can be made here to survey the extensive literature in this field; suffice it to say that most of such studies, beginning with the pioneer work of Galton in 1879, have been concerned with the measurement of associative reaction time, the classification of associations into various types, the determination of the degree of originality or commonality of an *S*'s responses, or the analysis of the *S*'s associations in order to reveal or diagnose

[1] The present paper represents part of a research project being conducted by Dr. C. N. Cofer and the senior author under a grant-in-aid from the American Association for the Advancement of Science. The writers are indebted to Dr. R. M. Gottsdanker for aid in the classification of the responses and to Dr. Cofer for a critical reading of a preliminary copy of the manuscript.

interests, attitudes, 'guilty' or technical knowledge, aptitudes, emotional 'complexes,' personality traits, pathological processes, and the like.[2]

The only studies directly relevant to the present paper are those in which an attempt was made to correlate some aspect of the *S*'s stimulational background with one or more characteristics of his verbal associations. Studies of association frequency as a function of such factors as chronological age or diagnostic syndrome are irrelevant, owing to ignorance of the specific stimulational factors involved. Likewise, many investigators, such as Mohsin (**13**), categorically state that the associations originated from 'past experience,' although their experiments were not specifically designed to determine whether or not this was the case.[3] A similar interpretation is made by Pintner (**15**), who designates 'habit' as one of the factors accounting for the 'free associations,' obtained annually from 1925 to 1943, to the item "Think of the name of a President of the United States."

Although primarily interested in the use of 'free association' for the diagnosis of abnormality in children, Goett (**10**) found a correlation between the type of 'free association' and the social class to which the children belonged. This result was especially true in the case of 'predicative associations' (e.g., *glass—brittle*, *father—good*), which were given by 60 percent of the children under 12 years of age from the 'proletariat' and by only 30 percent of the children of the same age from the 'better circles.'[4]

Rosanoff, Martin, and Rosanoff (**16**) have attempted to develop a free association technique "whereby a subject's mental capacity might be estimated from a measure of what he has acquired in the course of his education, and from a comparison of his acquisition with the average of a group of subjects of the same amount of education" (p. 2). The stimulus words consisted of 100 orally-presented technical terms, selected from different fields of academic learning (e.g., *Waterloo*, *isomerism*, *burette*, *coagulation*, *titration*, *syntax*, etc.). The writers present frequency tables of the associations of 1000 'superior' persons, including men of science, college professors, candidates for higher degrees, and college graduates. Norms on a 'High Standard' sub-group of 100 selected *S*s, such as starred men of science, are also reported. In order to study the effect of education upon frequency of a given response, various elementary school, high school,

[2] Typical studies are surveyed by Vernon (**18**, pp. 88–102) and Woodworth (**19**, pp. 340–367).

[3] The influence of 'mental set,' experimentally demonstrated by Mohsin (**13**), has been emphasized by a number of writers, such as Woodworth (**19**). Instead of regarding 'mental set' as a causative factor, a sort of hypostatized *deus ex machina*, however, it should be realized that 'mental set' is itself the result of immediately preceding stimulating conditions.

[4] The corresponding figures for children over 12 years of age were: 'proletariat' 40 percent, 'better circles' 25 percent.

and college groups were tested. With an abridged list of 41 'Class A' stimulus words, there was a completely consistent increase in frequency of 'High Standard' associations from the 5th grade in elementary school, through high school, college, and graduate levels, to starred men of science.

Murphy (**14**), using the first 100 stimulus words of the Woodworth-Wells association test (cf. **20**), studied the 'free associations' of 40 Yale seniors and faculty members, classified into five groups according to the experimenter's *a priori* estimate of their scientific *versus* literary interests and abilities. Certain differences between the associations of the 'literary' and the 'scientific' *S*s were found.

Burtt (**1**, **2**) has described a 'word association learning test' for the measurement of interest. Although not a test of 'free association,' the technique is relevant to the present discussion, since the underlying theory is the same. The method of paired associates learning was used, some of the pairs consisting of common and unrelated words, the other pairs involving technical terms dealing specifically with the type of work in question (e.g., agricultural engineering). The implicit theoretical assumption underlying this procedure is that the pre-experimental reinforcement of the technical associations in the case of the technically interested and trained *S* will result in his learning the technical associations more rapidly than will an uninterested individual; in each case, of course, it is the ratio of scores on the technical to scores on the neutral words which is to be compared.

Wyman (**21**, **22**) has reported an attempt to measure 'intellectual,' 'social,' and 'activity' interests of children by means of the 'free association' technique. The children's associations to each of 120 stimulus words were classified into the three above categories and the results correlated with teachers' rankings on the three kinds of interest. The obtained validity coefficients of +.65 ('intellectual'), +.50 ('social'), and +.31 ('activity') indicate a tendency for the child's 'free associations' to be related to his interests as estimated by teachers from his past behavior.

As one part of their 'M-F' Test, a personality test to determine the degree to which an *S*'s responses agree with the responses characteristic of men and women in our society, Terman and Miles (**17**, pp. 19–26) include a 'multiple-response association test.' The test in its final form contains 120 stimulus words, each followed by four multiple-choice responses or common associations to the stimulus word. The *S* is directed to indicate the one of the four responses which seems to him to 'go best' with the stimulus word. The response words were selected as those showing maximal differences in frequency between male and female groups. That sex differences in

association were obtained, that the associations could be diagnostically used for masculinity-femininity differentiation, and that such associations were often obviously related to the different modes of life of men and women in our society—all of these facts would appear to indicate the importance of stimulational factors in affecting the nature of the verbal associations obtained.

Perhaps the most relevant study is that of Goodenough (11), who reports the preliminary development of a 'free association' technique for the measurement of masculinity-femininity. A list of 240 visually-presented homographs [5] (e.g., *bow*, *file*, *ram*, *trip*, *ring*, *firm*, *box*, *ace*, etc.) were used as stimulus words, the responses being divided into classes and sub-classes on the basis of common characteristics of meaning empirically determined to have maximal differential weights [6] for the two sex groups of 400 *S*s each. Thus, for example, to the stimulus word *bow* responses of *hair* or *hair ribbon* were given exclusively by girls, responses referring to *archery* were predominantly masculine but with a sex overlap, responses referring to *persons* were not common but were slightly more frequent among girls, and responses referring to *knots* or *tying* showed little consistent sex trend. Goodenough's procedure clearly demonstrates that the verbal associations of boys and girls differ, presumably as a function of differences in their stimulational backgrounds, and that 'free associations' to ambiguous stimulus words provide a useful technique for such investigation.[7]

Method

Theoretically, professional training, as in law and medicine, consists of the establishment of specific conditioned responses to particular stimulating conditions; and not the least significant of these are verbal responses to verbal stimuli. Thus if a list of homophones, each admitting of legal, medical, and non-professional (neutral) interpretations, were presented in a 'free association' experiment, professionally trained *S*s would be predicted to give a larger proportion of professional associations in their respective fields, as compared with a control group of non-professional *S*s. The percentage of professional associations would likewise be expected to correlate with amount of professional training, and on the whole should be greater in the case of such ambiguous homo-

[5] Incorrectly reported by Goodenough as homonyms. A few of the words (e.g., *bow-beau*) would be homonyms if presented auditorily.

[6] Weights from 1 to 5 were assigned according to the probability of recurrence of a difference in the same direction as calculated by the χ^2 method; the direction of the difference, furthermore, had to be the same in each of the five age groups. Goodenough points out that in future work, the optimal weighting should be a function of the discriminative value of an item as indicated by small sex overlap and high internal consistency within single-sex groups.

[7] It will be noted that, unlike the stimulus words employed by Terman and Miles, those used by Goodenough were selected as having two or more discrete dictionary meanings, thereby increasing the probability of divergent associations among different criterion groups. Goodenough describes the use of homographs as stimulus words as "a practice that has the effect of increasing the spread of responses, because, in effect, different subjects are actually responding to different words, the selection of which depends on their own idiosyncratic pattern of interests and attitudes" (p. 102). The use of auditorily-presented homophones, as in the present study, would in many cases increase such a spread even further.

XUM

phones ('critical' list) than in the case of common words which do not possess conventionalized professional meanings ('neutral' list). As previously pointed out in the present paper, the empirical demonstration of verbal associations along a dimension established by professional training would immediately suggest a possible gradient for the operation of mediated generalization, although such 'free associations' themselves may have arisen to a large extent from direct conditioning or reinforcement.

1. *Materials:* The stimulus words consisted of 20 'critical' [8] and 20 'neutral' words, arranged in random order as indicated in the following list, in which the 'critical' words are in italics:

1. *confinement*	21. black
2. sour	22. *system*
3. rough	23. bible
4. *binding*	24. *discharge*
5. *constitution*	25. hard
6. girl	26. dream
7. king	27. *instrument*
8. *contract*	28. eagle
9. *solvent*	29. *compensate*
10. long	30. ocean
11. *hereditary*	31. lamp
12. river	32. *bear* (*bare*)
13. thirsty	33. *accident*
14. *expiration*	34. cottage
15. *chamber*	35. dark
16. *administer*	36. *void*
17. man	37. *tender*
18. blossom	38. tobacco
19. *complaint*	39. *cell* (*sell*)
20. *carrier*	40. cabbage

The word order was determined by chance, except that care was taken to avoid a sequence likely to be meaningful, or readily associated. The '*critical' words* were selected *a priori* by the writers on the basis of the following criteria: (*a*) each word should be an easily recognized English word in common usage; (*b*) it must have a legal, a medical, and if possible a neutral meaning or implication; (*c*) if possible, the legal and medical meanings should have approximately 'equal weight,' i.e., its legal meaning should be as common as its medical meaning, and vice versa; (*d*) the pronunciation of the word should be the same for its different meanings.

The criteria for the selection of the '*neutral' words* were as follows: (*a*) each word should be an easily recognized English word in common usage; (*b*) it should not have a common legal or medical meaning or implication; (*c*) the empirically determined most common verbal responses (associations) to it should have neither a legal nor medical meaning or implication; (*d*) there should be a high frequency or communality of verbal responses (associations) to each word, i.e., a large number of individuals (according to empirically established norms) should give the same verbal response to the word. The 'neutral' words were selected from those words in the Kent-Rosanoff frequency tables (12) which best fulfilled the above criteria.[9]

2. *Procedure:* The *S*s were tested in small groups during a regular class period. Each *S* was provided with a pencil and mimeographed data sheet with numbers from 1 to 40 inclusive. The following *instructions* were then read to the group: "This is a test of verbal association. I shall pronounce a word. As soon as I have pronounced it, you are to write down, in the appropriate space on your paper, the *first* word that occurs to you, i.e., the first word you think of after hearing the word that I pronounce. For example, if I say *window* and you think of *door*, you are to write

[8] Since these words were selected *a priori* by the writers, their essential 'critical nature' could be established only by the empirical data.

[9] The selection was in all cases automatic, in terms of magnitude of most common response frequency, except in the cases of the words *scissors*, *bed*, and *bath*, which were omitted on the basis of conditions (*b*) and (*c*) above. Reference to the Kent-Rosanoff frequency tables will reveal that the most common response frequency ranged between 650 and 338 (out of 1000) in the case of the 20 stimulus words selected.

down *door* immediately. Each word will be pronounced only *once*; it will not be repeated. Please do *not* make any interruptions or ask *any* questions whatsoever about the spelling or other characteristics of the stimulus words or anything else. Do not converse with your neighbor, and do not look at his data sheet: we want your own individual reactions. Please remember: you are to write down the very first word you think of after hearing the stimulus word. Write down only *one* word. Write it down regardless of what it is."

The words were then presented in the same order to all groups (*cf.* Materials), *E* pronouncing each word distinctly and without accent, and allowing 15 sec. for the *S*s to record their responses before presenting the next word. As indicated in the instructions, no word was repeated and, fortunately, no question was asked by any *S* during the presentation of the list to any group. At the conclusion of the experiment, the *S*s were asked to indicate name, age, sex, and year in college.

3. *Scoring and Treatment of Data:* The frequencies of the various responses to each of the 40 stimulus words were tabulated in each of the groups of *S*s. The next question was that of determining the 'legal,' 'medical,' or 'neutral' nature of each of such responses. For this purpose a master list of responses was prepared for each stimulus word: the master list contained the stimulus word at the top, followed by an alphabetized list of all the responses made to it by all *S*s in all groups. Only the responses themselves were given, with no indication of their frequency or of their distribution in the various groups of *S*s. Three judges [10] were asked to consider each verbal association in relation to the stimulus word and to judge the association as 'legal,' 'medical,' or 'neutral.' The last-named category was to apply to all associations which were neither predominantly legal nor medical; if a response was non-legal and non-medical or if it was ambiguous, it was to be classified as 'neutral.' The three judges worked independently, without knowledge of each other's judgments. The final classification assigned to each response was determined by agreement of two or all three of the judges.[10]

4. *Subjects:* A total of 218 *S*s were employed in the experiment. All of the *S*s were male, distributed as follows with respect to professional training at the time of the experiment:

First-year Law	40
Second-year Law	23
First-year Medicine	37
Second-year Medicine	43
Non-professional	75

The non-professional (control) group consisted of liberal arts students in elementary psychology classes; they were on the whole slightly younger than the *S*s in the professional groups, although the small age differential is not important in the light of their adult status. All *S*s were naive with respect to the purpose of the experiment.

Results

In Table I will be found the percentage of judged 'legal,' 'medical' and 'neutral' associations given by each group of *S*s to each of the 20 'critical' stimulus words; corresponding percentages for each of the 'neutral' stimulus words are presented in Table II. Looking first at the responses to the 'critical' words, we find that some of the words are heavily weighted toward the 'legal' or 'medical' type of response. Thus, for example, *confinement* and *constitution* seem to be predominantly 'legal' for all groups, as is *compensate* for all groups except the second-year medical. *Hereditary* elicits a preponderance

[10] Two of the judges were members of the Psychology Department; the third was a graduate student in psychology with some legal training. Recourse to professional lawyers and doctors as judges was abandoned in the light of the amount of time required to judge the large number of associations. The marked agreement of the three judges employed would seem to indicate the adequacy of the present procedure.

TABLE I

PERCENTAGE OF JUDGED 'LEGAL' (L), 'MEDICAL' (M) AND 'NEUTRAL' (N) RESPONSES GIVEN BY EACH GROUP OF SUBEJCTS TO EACH OF THE 20 'CRITICAL' STIMULUS WORDS *

Stimulus Words	First-Year Legal Group (N = 40)			Second-Year Legal Group (N = 23)			First-Year Medical Group (N = 37)			Second-Year Medical Group (N = 43)			Non-Professional Control Group (N = 75)		
	L	M	N	L	M	N	L	M	N	L	M	N	L	M	N
Confinement	80	13	8	87	9	4	76	11	14	89	5	7	72	7	21
Binding	8	8	85	13	0	87	11	11	78	5	19	77	9	5	85
Constitution	70	18	13	87	4	9	76	11	14	61	26	14	75	16	9
Contract	33	10	58	56	0	43	3	62	35	7	30	63	11	12	77
Solvent	30	10	60	30	13	56	0	46	54	0	44	56	15	17	68
Hereditary	18	58	25	13	56	30	0	86	14	0	84	16	3	55	43
Expiration	60	25	15	65	17	17	0	89	11	9	82	9	39	40	21
Chamber	3	20	78	17	17	65	11	16	73	5	14	82	4	4	92
Administer	38	30	33	52	26	22	8	76	16	16	68	16	21	47	32
Complaint	23	3	75	52	0	48	11	41	49	7	37	56	23	15	63
Carrier	40	5	55	52	4	43	3	27	70	2	28	70	12	9	79
System	18	5	78	17	4	78	5	70	24	0	84	16	9	29	61
Discharge	5	10	85	22	4	74	0	32	68	2	56	42	5	9	85
Instrument	5	15	80	9	22	69	3	78	19	2	58	40	3	24	73
Compensate	98	0	3	100	0	0	70	14	16	35	44	21	87	1	12
Bear (Bare)	0	0	100	0	4	96	0	3	97	0	0	100	0	0	100
Accident	20	3	78	22	4	74	0	19	81	5	28	68	1	17	81
Void	48	3	50	69	0	30	14	46	41	5	70	26	49	0	51
Tender	20	0	80	26	4	69	5	22	73	0	63	37	7	1	92
Cell (Sell)	25	13	63	26	30	43	11	62	27	14	70	16	31	15	55

* All percentages in this and the following tables have been rounded off to the nearest integer. Zero percentages, therefore, may represent an actual frequency greater than zero but less than 0.5 percent. For the same reason, the total percentages within any one category may not be exactly equal to 100.

of 'medical' responses in all groups, although it is not as predominantly 'medical' as *confinement* and *constitution* are 'legal.' Other 'critical' words, such as *binding*, *chamber*, *bear* (*bare*), and *accident* yield a majority of 'neutral' responses in all groups, *discharge* and *tender* also showing this result except in the case of the second-year medical *S*s. The remaining words show greater 'spread' of responses within a group of *S*s as well as from group to group, the best examples of such spread being found in the cases of *administer*, *complaint*, and *cell* (*sell*).

Most of the 'neutral' stimulus words yield an extremely high percentage of 'neutral' responses in all groups, as will be seen from Table II. Thus *blossom* and *ocean* are consistently 'neutral,' whereas *lamp*, *cottage*, and *dark* yield 100 percent 'neutral' associations in all but one group. Among the 'neutral' words resulting in the largest percentage of 'legal' or 'medical' associations are *sour*, *hard*, *dream*, and *eagle*, although in all of these cases, with the exception of the

TABLE II

PERCENTAGE OF JUDGED 'LEGAL' (L), 'MEDICAL' (M) AND 'NEUTRAL' (N) RESPONSES GIVEN BY EACH GROUP OF SUBJECTS TO EACH OF THE 20 'NEUTRAL' STIMULUS WORDS

Stimulus Words	First-Year Legal Group (N = 40)			Second-Year Legal Group (N = 23)			First-Year Medical Group (N = 37)			Second-Year Medical Group (N = 43)			Non-Professional Control Group (N = 75)		
	L	M	N	L	M	N	L	M	N	L	M	N	L	M	N
Sour	0	13	88	0	13	87	0	16	84	0	7	93	0	16	84
Rough	3	3	95	0	0	100	0	3	97	0	16	84	0	1	99
Girl	0	3	98	0	0	100	0	22	78	0	14	86	0	4	96
King	3	0	98	13	0	87	0	0	100	2	0	98	7	0	93
Long	0	0	100	0	0	100	0	3	97	0	2	98	0	0	100
River	0	0	100	0	0	100	0	3	97	0	0	100	0	1	99
Thirsty	0	0	100	0	0	100	0	0	100	0	7	93	0	1	99
Man	0	3	98	4	0	96	0	0	100	0	14	86	0	1	99
Blossom	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100
Black	5	0	95	9	0	91	0	3	97	0	5	96	1	0	99
Bible	3	0	98	0	0	100	3	0	97	2	2	96	1	0	99
Hard	3	0	98	4	0	96	0	11	89	0	28	72	0	0	100
Dream	0	10	90	0	4	96	0	27	73	0	49	51	0	3	97
Eagle	0	10	90	0	9	91	0	19	81	0	19	82	0	12	88
Ocean	0	0	100	0	0	100	0	0	100	0	0	100	0	0	100
Lamp	0	0	100	0	0	100	0	0	100	0	2	98	0	0	100
Cottage	0	0	100	4	0	96	0	0	100	0	0	100	0	0	100
Dark	0	0	100	0	0	100	0	3	97	0	0	100	0	0	100
Tobacco	0	3	98	0	0	100	0	5	95	0	9	91	0	0	100
Cabbage	0	3	98	0	4	96	0	5	95	0	0	100	0	1	99

responses to *dream* made by the second-year medical group,[11] the associations are overwhelmingly 'neutral.' The difference between the 'critical' and 'neutral' words in number of 'professional' *versus* 'neutral' associations would appear to indicate the success with which the two sets of stimulus words were chosen, since it will be recalled that the former were selected on purely *a priori* grounds and the latter from the Kent-Rosanoff list in terms of magnitude of the most common response frequency.

The mean percentages of 'legal,' 'medical,' and 'neutral' associations given by each group are reported in Table III. In the case of the '*critical*' *stimulus words*, it is found that the mean percentage of 'legal' responses is greater than that of 'medical' responses in both legal groups, whereas the percentage of 'medical' responses is greater

[11] The relatively large percentage (49 percent) of 'medical' responses made by the second-year medical group to the 'neutral' stimulus word *dream* can be understood in terms of the 'mental set' aroused by the two immediately preceding stimulus words *discharge* and *hard* (*cf.* Materials). Although an attempt had been made to avoid a sequence of stimulus words likely to be professionally meaningful, or readily associated, many of the second-year medical subjects perceived medico-sexual connotations in this sequence, as indicated by such responses as *Freud, orgasm, psychiatry, psychoanalysis*, and *sex*, so that intra-serial factors were at least in part involved in the relatively large percentage of 'medical' associations made by this group.

than that of 'legal' responses in both medical groups. Furthermore, there is a small but consistent trend toward increasing percentage of 'legal' or 'medical' responses from the first to the second year of professional training. The responses of the non-professionally trained (control) group are predominantly 'neutral.' If we take the

TABLE III

MEAN PERCENTAGE OF JUDGED 'LEGAL' (L), 'MEDICAL' (M) AND 'NEUTRAL' (N) RESPONSES GIVEN BY EACH GROUP OF SUBJECTS TO THE 'CRITICAL,' 'NEUTRAL,' AND COMBINED LIST OF STIMULUS WORDS

Stimulus Words	First-Year Legal Group (N = 40)			Second-Year Legal Group (N = 23)			First-Year Medical Group (N = 37)			Second-Year Medical Group (N = 43)			Non-Professional Control Group (N = 75)		
	L	M	N	L	M	N	L	M	N	L	M	N	L	M	N
'Critical' Words	32	12	56	41	11	48	15	41	44	13	46	42	24	16	60
'Neutral' Words	1	2	97	2	2	97	0	6	94	0	9	91	0	2	98
Combined List	16	7	77	21	6	72	8	24	69	7	27	66	12	9	79

control group as a basis or standard of comparison, it is found that the first and second year legal groups make 8 percent and 17 percent *more* 'legal' responses, respectively, than does the control group, whereas they make 4 percent and 5 percent *fewer* 'medical' responses, and 4 percent and 12 percent *fewer* 'neutral' responses. The first and second year medical groups make 25 per cent and 30 percent *more* 'medical' responses, respectively, than the control group, 11 percent *fewer* 'legal' responses, and 16 percent and 18 percent *fewer* 'neutral' responses, respectively.

The responses to the '*neutral*' *stimulus words* show a mean of 91 percent or more 'neutral' responses in every group, the largest percentage (98 percent) of such responses being shown by the control group. Although there are relatively few 'professional' responses to the 'neutral' stimulus words, there is a small but rather consistent tendency for the legal group to give slightly more 'legal' associations and the medical group more 'medical' associations than the control group. Thus, the first and second year legal groups give 1 percent and 2 percent *more* 'legal' associations, respectively, than the control group, whereas they give the *same* percentage of 'medical' associations, and 1 per cent *fewer* 'neutral' associations. The first and second year medical groups give 4 percent and 7 percent *more* 'medical' associations, respectively, than does the control group, and give the *same* percentage of 'legal' associations, and 4 percent and 7 percent *fewer* 'neutral' associations. The tendency for increasing percentage of 'professional' responses to be correlated with increasing amount of

professional training is here suggested in the case of the medical groups, although the tendency is obviously not as marked as in the case of the 'critical' stimulus words, discussed above.

The same general results are obtained when the percentages of different types of responses to the *combined list* of 40 stimulus words are analyzed. Although 'neutral' responses are most common in all groups, 'legal' responses are more numerous than 'medical' responses in the legal group, and 'medical' outnumber 'legal' responses in the medical group, each of the professional groups showing a small increase in percentage of associations within its own field with increased amount of professional training.

Of all of the intercomparisons possible in the present study, perhaps the most crucial is that involving a comparison of the total legal and total medical groups with respect to the percentage of 'legal' and 'medical' responses to the 'critical' stimulus words. Such data are presented in Table IV. It will be noted that the legal

TABLE IV

RELIABILITY OF THE PERCENTAGES OF 'LEGAL' AND 'MEDICAL' RESPONSES TO THE 'CRITICAL' STIMULUS WORDS IN TOTAL LEGAL AND TOTAL MEDICAL GROUPS

Type of Response	Legal Group			Medical Group			Legal-Medical Difference		
	N	P	σ_P	N	P	σ_P	Diff.	$\sigma_{Diff.}$	Significance Ratio
'Legal'.....	63	35	6.0	80	14	3.9	21	7.1	3.0
'Medical'.....	63	12	4.1	80	44	5.6	−32	6.9	−4.6

group as a whole gives 21 percent *more* 'legal' associations to the 'critical' stimulus words than the medical group, this difference yielding a significance ratio of 3.0. The medical group gives 32 percent *more* 'medical' associations than the legal group, the significance ratio of this difference being 4.6. Each of these significance ratios indicates that there are well over 99 chances out of 100 that the obtained difference could not have arisen as a sampling error from a true difference of zero.

Space does not permit publication of the specific responses made to each stimulus word, together with the frequencies of such responses. By way of example, we may take the 'critical' stimulus word *administer*, the responses to which admirably illustrate intergroup differences in frequency of the three types of response (*cf.* Table I). Combining the responses of the various groups, we find the following complete list of 'legal' responses: *administrator, administrative, business, decreed, direct, estate, execute, execution, executive, govern, government, handled, judge, justice, law, money, oath,*

president, punishment, render, rule, senate, settle, swear, taken over, wills. The 'medical' responses to the same stimulus word include: *adenoids, aid, anesthetic, attend, doctor, dosage, dose, drug(s), first aid, give(s), give aid, heal, inject, medicine, operation, saline solution, sick, syringe, treat.* Finally, the 'neutral' responses are as follows: *beating, blows, boss, care, deal, deliver, dictate, distribute, do, ecclesiastical, escape, foreman, friend, help, inspire, instigate, liquor, minister, official, preacher, present, priest, pronounce, Red Cross, receive, sacrament, sermon, set forth, serve, service, spoon, succor, supervise, take care, task, tell, tests, use, wait upon.*

Thus, it would appear that professional training definitely influences the type of response elicited in the 'free association' experiment.[12] In fact, professional training might be said to involve a conditioning process in which certain prescribed stimulation is imposed upon the trainee for the establishment of specific conditioned behavior. And not the least important of such behavior are the verbal responses characteristic of different professional groups. That such verbal conditioning acquired in the course of professional training influences the 'free associations' of an *S* seems strongly suggested by the present results. Not only do the same 'critical' stimulus words elicit more 'legal' than 'medical' responses in the legal group and more 'medical' than 'legal' responses in the medical group, but there is a slight tendency for this to be true also in the case of 'neutral' stimulus words; and there is a definite tendency toward a greater degree of 'legal' or 'medical' type of response with increased amount of professional training. Not only do direct verbal associations occur along a dimension established in part by professional training, but such associations provide a possibility for the operation of mediated generalization along such 'professional' gradients.

Summary

This experiment was designed to demonstrate differences in type of verbal responses in the 'free association' experiment as a function of differences in type and amount of professional training. Results indicate professional differences in such associations, thus affirming the occupational conditioning of verbal reactions and suggesting the possibility of the operation of mediated generalization along 'professional' gradients.

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[12] For evidence concerning the occupational conditioning of other responses (e.g., motor speed and preferential auditory tempo) *cf.* Foley (5, 6, 7).

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STRUCTURE EFFECTS WITHIN A MEMORY SERIES *

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H. von Restorff (**8**) systematically demonstrated that within a memory series consisting of two types of items, those of less frequent occurrence are favored in recall, e.g., two numbers among eight nonsense syllables. This finding bolsters the Gestalt proposition that memory traces are subject to the same grouping or structuring factors that govern the realm of 'perception.' [1] Within such a series, items of less frequent occurrence tend to become '*isolierte*' in the trace field, i.e., isolated or having a 'figure' property. Conversely, those of greater frequency are '*gehäufte*' in the trace field (massed or homogeneous, having a 'ground' property, hence recalled with less facility). Bartlett (**1**), Katona (**3**), Koffka (**4**), and Köhler(**5, 6, 7**) have further developed the role of spatial and temporal organization in their respective mnemonic systematizations.

If von Restorff's principle of 'isolation and homogeneity' [2] is as strongly operative in the trace field as the evidence suggests, the following proposition should be experimentally demonstrable: Within a single, unitary memory series consisting of two item types, the two occurring with *equal* frequency, *relative* isolation and homogeneity should influence the recall strength of certain critically placed individual items. Such a series would offer neither isolation nor homogeneity in terms of the total or the overall frequency of item type occurrence. Relative isolation and homogeneity then, are synonymous with in-group structure.

The perceptual analogy is an excellent technique for introducing clarity. In the hypothetical series below (consisting of ten *X*'s and ten *O*'s), the *i* symbols have a strong tendency to take on individuality or a 'figure' property. Those designated with the *h* symbol are massed or homogeneous and tend to surrender their identity within a neutral structure or 'ground.'

$$X\ X\ O^{i}\ X\ X\ X^{h}\ O\ X\ O\ X\ O\ O\ X^{i}\ O\ O\ O^{h}\ X\ O\ X\ O$$

* Dr. Sigmund Koch and Dr. K. E. Zener, Duke University, contributed valuable suggestions.

[1] Most distinctions between 'memory' and 'perception' have, of course, always been recognized as being arbitrary.

[2] This is a convenient designation. Hereafter, quotation marks will be omitted.

This points to the expectancy that within a memory series of comparable structure, critically placed items should be similarly weighted in recall.

Procedure

Ten nonsense syllables and 10 numbers were used. Since nonsense syllables usually enjoy a uniquely greater recall expression, two lists were constructed from the same 20 items. The second list or series reverses all syllable-number positions; i.e., where a number is placed in Series 1, a syllable is placed in Series 2. In the evaluation of recall results, an average of the horizontal pair in any given position cancels item type weighting. Any effect that then obtains is independent of this factor.

TABLE I

Structure of Series 1 and Series 2

Position	Perceptual Analogy	Series 1	Series 2
1.	X	gub	341
2.	X	kev	258
3.	O[i]	406[i]	sih[i]
4.	X	dac	179
5.	X	rul	417
6.	X[h]	hof[h]	562[h]
7.	O	763	fip
8.	X	vom	738
9.	O	581	ter
10.	X	waj	269
11.	O	341	gub
12.	O	258	kev
13.	X[i]	sih[i]	406[i]
14.	O	179	dac
15.	O	417	rul
16.	O[h]	562[h]	hof[h]
17.	X	fip	763
18.	O	738	vom
19.	X	ter	581
20.	O	269	waj

In the order indicated, each series was presented to 70 *S*s recruited from the War College at Davidson. Small groups of 17 to 30 *S*s were used in each presentation.

Instructions were as follows: "This is a memory experiment. On the desk before me is a series of cards. Each card has an item printed on it. I shall hold each up for a short interval of time and I want you to try and remember as many items as you can. The order makes no difference. I am interested only in the *total number* of items that you recall correctly. Please attend carefully and avoid making any comments."

The cards (3 by 5 inches with heavy black lettering) were held up for five seconds each in a carefully rehearsed rhythm. Following the last, the subjects were asked to record on paper.

A rigorous scoring criterion was observed. Only those items recalled with absolute fidelity are represented in the results. The substitution of capital letters for small letters was not penalized.

Results and Discussion

Since 70 *S*s learned each series, 70 correct recalls would represent the maximum for any position.

The results, as presented in Table II, clearly verify the expectancy. A consideration of the horizontal pair averages (last column) indicates that positions 3 and 13 do enjoy the highest incidence of recall.

TABLE II

RESULTS FOR SERIES 1 AND SERIES 2

	Series 1	Number Correct Recalls	Series 2	Number Correct Recalls	Horizontal Pair Totals	Horizontal Pair Averages
1.	gub	38	341	18	56	28.0
2.	kev	34	258	16	50	25.0
3.	406[1]	30	sih[1]	48	78	39.0*
4.	dac	18	179	9	27	13.5
5.	rul	17	417	9	26	13.0
6.	hof[h]	9	562[h]	1	10	5.0*
7.	763	16	fip	25	41	20.5
8.	vom	16	738	5	21	10.5
9.	581	13	ter	30	43	21.5
10.	waj	22	269	6	28	14.0
11.	341	11	gub	39	50	25.0
12.	258	17	kev	25	42	21.0
13.	sih[1]	44	406[1]	40	84	42.0*
14.	179	9	dac	18	27	13.5
15.	517	7	rul	14	21	10.5
16.	562[h]	3	hof[h]	7	10	5.0*
17.	fip	23	763	5	28	14.0
18.	738	7	vom	22	29	14.5
19.	ter	28	581	10	38	19.0
20.	269	18	waj	22	40	20.0

Positions 6 and 16 manifest the lowest. Before we conclude, however, that in-group structure (relative isolation and homogeneity) may determine the recall strength of individual items within a memory series, other more economical explanations must be treated. The first two considerations necessitate a control series. The last can be dealt with adequately in terms of the present results.

(*a*) Possibly our selection of the critical items *sih*, *406*, *hof*, and *562* was an unfortunate one. Independently of the structure of the series, perhaps they possess some unique weight that determines their recall value.

(*b*) Perhaps their positions in the time sequence are somehow weighted; i.e., in independence of the nature and structure of the other items, positions 3, 6, 13, and 16 may be favorably or unfavorably placed in time (another structure effect?).

(*c*) Finally, an alternative hypothesis (advanced in other contexts and treated effectively by Restorff) might be considered. Perhaps isolation and homogeneity are reducible to contrast effects resulting from the disruption of an '*Einstellung*' or 'set.' Thus, position 3 is favored by its deviation from the 'set' established by the first two items (pointed up by contrast). Conversely, position 6 conforms to the 'set' more closely and is therefore unfavorably located for emphasis.

The 'set' hypothesis does not, however, explain the recall strength of position 13, well along in the series and actually preceded by more of its kind than by items of a different type—seven to five. Further,

this hypothesis would fallaciously ascribe dominance to positions 7 and 17 (immediately preceded by the largest number of unlike items).

For these reasons, we discard the 'set-contrast' explanation. The strength of our argument now rests upon the outcome of a control of alternatives (*a*) and (*b*).

Procedure in the Control of Alternatives (*a*) and (*b*)

Again to control item type weighting (see Procedure, experimental series), two lists were constructed from the same material (see Table

TABLE III

Structure of Series 3 and Series 4

Position	Perceptual Analogy	Control Series 3	Control Series 4
1.	X	269	kev
2.	O	kev	269
3.	X	406	sih
4.	O	dac	179
5.	X	258	rul
6.	O	hof	562
7.	X	763	fip
8.	O	vom	738
9.	X	581	ter
10.	O	waj	417
11.	X	341	gub
12.	O	sih	406
13.	X	179	dac
14.	O	rul	258
15.	X	562	hof
16.	O	fip	763
17.	X	738	vom
18.	O	ter	581
19.	X	417	waj
20.	O	gub	341

TABLE IV

Results of Control Series

	Series 3	Number Correct Recalls	Series 4	Number Correct Recalls	Horizontal Pair Totals	Horizontal Pair Averages
1.	269	28	kev	31	59	29.5
2.	kev	33	269	26	59	29.5
3.	406	16	sih	29	45	22.5*
4.	dac	15	179	17	32	16.0
5.	258	15	rul	9	24	12.0
6.	hof	13	562	7	20	10.0*
7.	763	10	fip	6	16	8.0
8.	vom	11	738	2	13	6.5
9.	581	4	ter	14	18	9.0
10.	waj	11	417	9	20	10.0
11.	341	2	gub	18	20	10.0
12.	sih	14	406	10	14	7.0*
13.	179	4	dac	4	8	4.0
14.	rul	9	258	5	14	7.0
15.	562	2	hof	11	13	6.5*
16.	fip	13	763	2	15	7.5
17.	738	3	vom	23	26	13.0
18.	ter	15	581	4	19	9.5
19.	417	18	waj	24	42	21.0
20.	gub	28	341	14	42	21.0

III). The temporal positions of the same four critical items were preserved approximately. This time, the two item types were staggered in a neutral structure.

The reader will notice that the critical items from position 16 of the experimental series were shifted to position 15 of the control series; and that items from position 13 in the experimental series were shifted to position 12 in the control series. This is dictated by the structure of the control series and is assumed to be a negligible change.

Each series was presented to 50 *Ss* recruited from the same source. The same procedure and scoring technique were observed.

Discussion

With high points at the beginning and end of the series, the results of the control series are typical for the recall of neutrally structured rote material. Critical positions 3, 6, 12, and 15 do not enjoy the unusual recall values seen in the experimental series,[3] i.e., 3 and 12 do not have the greatest recall strength, nor do 6 and 15 manifest the lowest. We must conclude that neither intrinsic item weight nor temporal position as such will explain our earlier results.

Since a different number of *Ss* participated in the two series (experimental—140, reduced to 70 in averaging; control—100, reduced to 50), quantitative comparisons can be made only in terms of percentages of recall. For positions 3 and 13, favored by relative isolation in the experimental series, these amount to 56 and 60 percent, respectively. The same critical positions [4] in the neutrally structured control series yield recall percentages of 45 and 14 respectively. Those positions, disadvantageously structured in the experimental series (relatively homogeneous), yield recall percentages of 7 each. In the control series, they give percentages of 20 and 13.

The one independent variable distinguishing the experimental series from the control is its structure. We must conclude that this factor is crucial in the production of differential recall results. These experiments are regarded, then, as strong evidence for the Gestalt organizational laws of memory, or more particularly, for von Restorff's principle of isolation and homogeneity.

Gibson's analysis of memory (2) employing S–R constructs, very nicely generates Restorff's original results. It is conceivable that with some slight extension, the results here might be similarly deduced.

[3] It will be remembered that positions 12 and 15 must be compared with positions 13 and 16 in the experimental series (see Procedure, control series).

[4] Critical here, only in the sense that these positions contain the same critical items, relatively isolated or homogeneous in the experimental series.

Summary

One hundred and forty *S*s were asked to memorize a structured series of rote material consisting of two types of items occurring with equal frequency. Recall results for critically-located individual items confirmed von Restorff's principle of isolation and homogeneity (in this case, *relative* isolation and homogeneity).

One hundred *S*s, comprising a control, were asked to memorize the same material in a neutral structure. The failure to yield unique recall values conformed to the theoretical expectancy.

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XUM

THE RETENTION OF A SIMPLE RUNNING RESPONSE AFTER VARYING AMOUNTS OF REINFORCEMENT

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Introduction

In a previous investigation of the effects of varying conditions of reinforcement upon the acquisition and subsequent retention of a simple running response of the rat, one of the writers observed that doubling the number of acquisition trials decreased, rather than increased, the 24-hour retention of the habit (2). The response in question was the traversal of a simple runway to obtain food, with latency of reaction the measure of its strength. These preliminary results suggested that some factor may operate to fix the minimum latency after a retention period, regardless of the number of learning trials and the final level of acquisition. The present experiment was designed to extend the range of these observations, with the measurement of retention 24 hours after acquisition series of 4, 8, 16, and 32 trials. It will be shown that although latency at the end of acquisition is a function of the number of reinforced trials, the average speed of response 24 hours later is independent of this factor; all groups respond with virtually identical latencies.

Apparatus and Procedure

The apparatus and procedure have been described more fully elsewhere (1, 2). The reaction studied was the running of a simple elevated runway, 3 ft. long and 1¼ in. wide, connecting a starting box and a food box. The strength of response in any trial was measured in terms of 'latent period,' defined as the time elapsing between the opening of the starting box door and the rat's crossing of a line 4 in. down the runway. Reinforcement was given in the food box at the end of each acquisition trial, in the form of a small Purina chow pellet. Four preliminary daily sessions preceded the experimental session, to acquaint the rat with the type of runway and reinforcement used in the test trials.

The animals were divided into four groups receiving, respectively, 4 acquisition trials (Group I), 8 acquisition trials (Group II), 16 acquisition trials (Group III), and 32 acquisition trials (Group IV). The inter-trial interval was in each instance 75 sec.

Twenty-four hours following the last acquisition trial each rat was placed again in the starting box of the apparatus and the degree of retention was measured in terms of latency of

response. To indicate the early trend of extinction, 9 additional trials were given at 75-sec. intervals, all without reinforcement by food.

Each group of animals consisted of 11 male albino rats from the laboratory colony of Brown University.* The rats were drawn from four litter-groups and averaged 82 days of age at the time of the first experimental session (range 67 to 111 days). The animals were selected in such an order that the four groups were closely matched with respect to litter and age.

Results

Figure 1 is the combined acquisition curve for all rats, with average latency given in logarithmic units. All four groups contribute to the first four points, Groups II, III, and IV are represented in

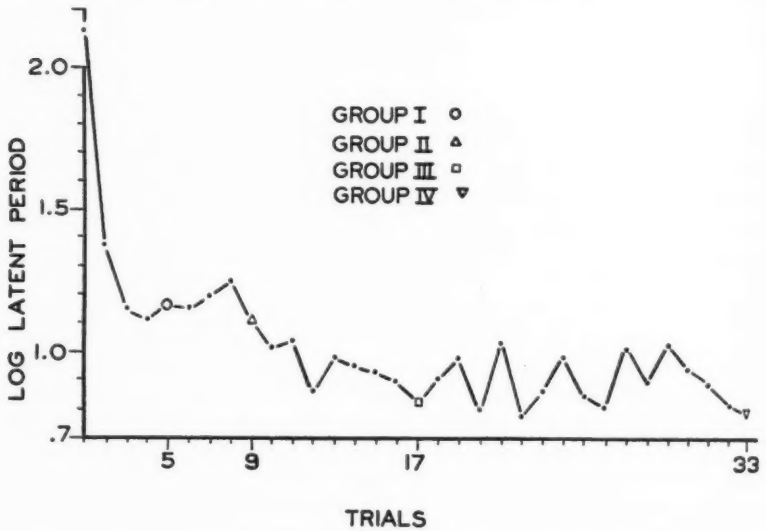

Fig. 1. Average latencies during acquisition for all 44 animals. Forty-four animals contribute to points 1–4, 33 to points 5–8, 22 to points 9–16, and 11 to points 17–32. The last point on the curve is extrapolated.

trials 5–8, Groups III and IV in trials 9–16, and Group IV in trials 17–32. The trend usually observed in this experimental situation is followed, with rapid improvement for the first four trials, a brief rise in latency, and a further decrease to the final level, which is reached soon after the 12th trial. The latter half of the curve is marked by considerable trial-to-trial variability.

The data of retention and subsequent extinction are shown in Fig. 2. The first points represent the hypothetical response level

* The writers wish to express their appreciation to Dr. W. S. Hunter for generously supplying the experimental animals from the Brown University animal colony.

of each group immediately after acquisition, i.e., on trials 5, 9, 17, and 33 (extrapolated) on the combined curve. These points indicate the level of response that would have been expected immediately following the last acquisition trials, had not the retention period intervened. The dotted lines depict the change in habit strength

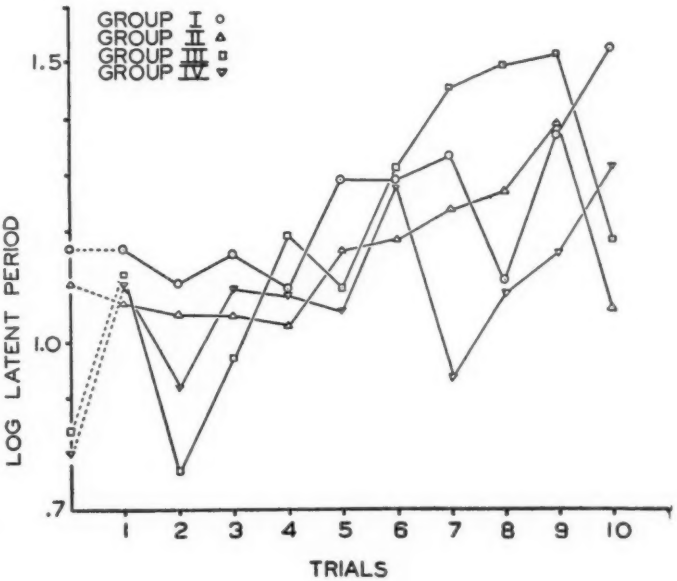

FIG. 2. Average latencies during the extinction series 24 hours after the last acquisition trial. The points on the ordinate line represent the hypothetical response level of each group immediately after acquisition. The second points represent the latent period obtained on the first non-reinforced (first extinction) trial.

resulting from the interpolation of the 24-hour retention period, with the second points representing the retention trial. The solid lines connecting the 10 non-reinforced trials on the second experimental day indicate the course of extinction.

It may be seen, both in Fig. 2 and Table I, that the final level after 16 and 32 trials (Groups III and IV) is markedly lower than the final level after 4 and 8 trials (significant beyond the 1 percent level). Following the 24-hour interval, however, this relationship no longer obtains. Retention, as measured by latent period, is virtually complete for Groups I and II, since the response time is unchanged. In Groups III and IV, on the other hand, a significant loss has occurred; all four groups now respond with approximately equal latencies. It would seem, from a comparison of the final acquisition level and

response 24 hours later, that the degree of retention is inversely related to the amount of original reinforcement.

As we follow along the curves of extinction we see that there is little change in latency for Groups I and II on trials 2, 3, and 4.

TABLE I

FINAL LEVEL OF ACQUISITION AND RETENTION 24 HOURS LATER

Group	Number Acquisition Trials	Final Acquisition Level			Retention Trial	24-Hr. Loss
		Trial No. on Combined Curve	*N*	Log Latent Period	Log Latent Period	Log Latent Period
I	4	5	33	1.16	1.17	0.01
II	8	9	22	1.10	1.07	−0.03
III	16	17	11	0.83	1.08	0.25
IV	32	33*	11	0.80	1.10	0.30

* Extrapolated.

Both Group III and Group IV, however, show extremely rapid responses on the second trial. On succeeding trials these animals show a relatively rapid increase in latent period, so that by the 4th trial they are responding at least as slowly as Groups I and II. Further comparison of the groups is of questionable validity, because of the irregularly decreasing number of subjects contributing to each point. By the 10th extinction trial 9 rats are responding in Group I, 9 in Group II, 6 in Group III, and 8 in Group IV (extinction criterion of 3 min. non-response).

In summary, it may be said that the final acquisition level is more advanced after 16 or 32 trials than after 4 or 8 trials. Retention is relatively poor in the 16- and 32-trial groups, so that with the exception of the second and third points on the extinction curves, there is little difference among the four groups in either retention or extinction.

DISCUSSION

The acquisition data are in agreement with the results of previous experiments (**1, 3, 4**): there is little improvement in response time between trials 4 and 8, and after trial 16, but the response after 16 acquisition trials is clearly more prompt than after 8 trials. The addition of the 4-trial and 32-trial groups apparently confirms the observation (**2**) that there is no decrease in habit strength over a 24-hour retention period in rats having received less than 16 acquisition trials, but that marked 'forgetting' occurs in animals having received more extended training.

There is no obvious explanation for this anomalous inverse relationship between acquisition and retention. The only clue seems to be in the one or two trials following the retention test, i.e., the second and third extinction trials. Groups I (4 trials) and II (8 trials), in which no loss occurs over the 24 hours, show little variation in the first few extinction trials. Groups III and IV, on the other hand, demonstrate remarkable fluctuations during these trials. The retention trial, being unreinforced, would be expected to produce a subsequent increase in latent time. But the opposite effect occurs, so that the next trial is faster for Group III (16 acquisition trials) than any during the acquisition series, and for Group IV (32 acquisition trials) nearly as fast as the last acquisition trial. This 'warm-up' effect suggests that the retention trial does not yield a true measure of the condition of the habit-pattern after the 24 hours, and that retention in Groups III and IV is actually more complete than this single test trial would indicate. On the other hand, the later trend of extinction fails to reveal any such superiority for Groups III and IV; their curves are no less steep than those obtained with Groups I and II, and more rats in Groups III and IV have ceased to respond by trial 10 than in the other groups. It might appear either that the hypothesized inhibition of reinforcement which leads to rapid extinction after a longer acquisition series (see 1, p. 66) is only partially dissipated during the interpolated 24-hour interval, or that the latency trend during extinction is not a sensitive index of degree of original learning.

The existence of a 'floor' effect at the retention trial seems to be established more firmly (2, p. 130). Thus far it appears than an average response time faster than 1.05–1.10 log units is impossible 24 hours after acquisition, regardless of the number of training trials. The improvement on the succeeding trial for the 16- and 32-trial groups, however, demands further clarification. Perhaps a warming-up period for these groups, immediately preceding the retention test, would result in a latency on that trial as short as that obtained on the following trial. This warm-up might be accomplished by a few minutes on the preliminary runway, by a longer stay in the starting box, or by the presentation of a few food pellets. These variations in procedure, plus the use of different retention periods, may shed additional light on the nature of this retention phenomenon.

Summary

Four groups of 11 rats each were trained in a simple runway problem, with 4, 8, 16, and 32 acquisition trials, respectively. Twenty-four hours later the animals were tested for retention, and 10 points

on the extinction curves determined. Strength of response was measured in terms of latent period.

1. At the end of acquisition the groups which had received 4 and 8 trials were responding with approximately equal promptness.

2. There was also little difference between the average latency of the 16-trial and the 32-trial groups, but both responded significantly faster than the other 2 groups.

3. After the 24-hour retention period, there was no reliable difference among the four groups: the 4- and 8-trial groups were marked by complete retention, while the 16- and 32-trial groups showed considerable loss.

4. Except for a temporary improvement of response on the second extinction trial for the 16- and 32-trial groups, the four extinction curves were not greatly dissimilar. There was perhaps a slight tendency for less rapid extinction in the 4- and 8-trial groups.

There seems to be a factor operating immediately after a 24-hour retention period that makes impossible an average response faster than about antilog 1.05–1.10 sec. The fluctuation on the trials directly following the retention test suggests that a temporary condition of the organism may mask the expression of the true habit strength in the absence of a pre-test warm-up period.

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BEHAVIORAL CHARACTERISTICS OF MONOTONY IN TWO AGE GROUPS

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While considerable research has been reported in the literature on the effects of monotony upon adults, few studies have been concerned with monotony in children. The objective of this paper was to determine the extent of monotony in children and to compare its manifestations with monotony in adults.

Experimental Design

The *S*s for this experiment were 23 pre-school children of mean C.A. = 48.40 months and 40 college sophomores of mean C.A. = 19.17 years. The pre-school sample consisted of the total enrollment of the 1940 semester at the nursery school attached to the University of California, Institute of Child Welfare, with certain *S*s ruled out who for emotional or other reasons were not open to experimentation. The college sophomores were chosen randomly from the entire 1940 fall enrollment in the Psychology 1A class at the University of California. The sexes were about equally represented in each sample.

The objective in experimental design was to provide a single but simple task which would be interesting to both child and sophomore and yet induce monotony with repetition at both age levels. Continuous reproduction of simple circular dotted figures—'moon-faces'—satisfied this requirement.

The experimental conditions for both age groups were held as comparable as possible. As indicated below, some slight deviation in procedure, however, had to be made with respect to the adults in order to adjust the task to their level of maturity. For testing purposes, each pre-school *S* was approached individually on the nursery playground and asked if he would like to go upstairs and play a 'new' game. If he evinced interest, he was taken to the experimental room. No child was selected who appeared fatigued or sleepy, and each *S* was taken to the toilet before the trials began. Once in the experimental environment he was shown blank paper and a large crayon and was asked if he would like to draw. If he was ready to draw, he was shown a free-hand drawing of a circle with three dots representing a face (moon-face). *S* was told it was a 'moon-face' and then was asked if he cared to draw one like it. Attention was called to all the details of the original configuration. When *S*'s drawing was finished, he was interrogated as to its similarity to the original. His drawing was then removed. He was given a clean sheet of paper and asked to draw another. As soon as one drawing was finished it was withdrawn and a new sheet substituted with the request to draw another. Only one drawing was permitted on a sheet. The *S* was told that he could draw as many as he liked. *S* soon learned to reach for a new sheet voluntarily when a drawing was completed. The reproductions continued until the child stated he desired to stop, refused to draw any more, or left the table and refused to return. As in previous studies, this was considered the criterion of monotony. Each child was observed after the task to determine that the rejection of the task or the 'leaving of the field' was not due to toilet needs, sleepiness, or other extraneous interference, and the data of two such *S*s were discarded for these reasons.

Each college *S* was tested individually and was given the following instructions upon appearing at the laboratory:

* The experimental work for this study was done at the University of California, Berkeley.

"This is an experiment to study certain aspects of motor behavior. Your task is to draw simple figures called 'moon-faces.' [The original used with pre-school children was shown.] You can see that it consists of a face or circumference, and two eyes and a nose represented by three dots. Do not correct the figure once you have drawn it.

"On the signal begin drawing a series of 'moon-faces' on this paper. There are pencils here for your use. Now this is important: Continue drawing *moon-faces until you are fed up and have had enough of it.* When that time comes you may stop.

"From time to time I will give you a short rest period. I will let you know when that time comes. Speed is not a factor in this experiment and this is not a test of persistence. Do you understand?"

Each sophomore *S* worked for four minutes and then rested one. This was necessary to prevent the development of fatigue. The *S*s were not told when a rest pause would occur and the directions were not elaborated; *E* did not converse with *S* nor answer questions once the experiment was under way.

When the sophomore *S* had finally rejected the task after a series of drawings; i.e., was satiated, he was given the regular one-minute rest pause, and then shown a new figure. This figure was identical with the original figure with the exception that a plus sign in the upper half of the circle replaced the three dots. It is easily seen that the manual movements required to draw a plus sign are not strongly dissimilar to those required to make three dots in the same two planes. In the first instance, after the circle is drawn, the pencil must be placed on a horizontal point within the circumference then moved a short distance, and lifted. The pencil is then transported to a vertical point above the horizontal line, and moved through the horizontal line to a point below, and lifted. In the second instance, the 'moon-face,' a horizontal point is located and marked; the pencil is then transported to a second horizontal point, marked and lifted. It is then transported to a point below the horizontal plane and marked, then lifted. The motor similarity between the two figures is thus fairly clear.

Each *S* was unaware during the first part of the experiment that he was to draw a second figure in the second half of the experiment. This precluded the possibility of some of the *S*s 'saving themselves' for the second task.

The presentation of the second task was for the purpose of determining monotony-transfer. Monotony-transfer [1] can be defined as the transfer of monotony effect from one task to another.

Results and Discussion

The children drew an average of 19.56 ± 4.79 drawings before becoming satiated. The average time required to become satiated was 9 min. 16 sec. ± 1 min. 8 sec. (Table I). No monotony-transfer indices were obtained for this group.

TABLE I

Mean Time and Number of Drawings Necessary to Induce Monotony in Pre-School Children and to Induce Monotony and Co-Monotony in College Students

	Monotony		Co-Monotony	
	Time	Number	Time	Number
Sophomores .	17 min. 36 sec. ±1 min. 36 sec.	392±44.53	7 min. 22 sec.±38 sec.	218.33±27.85
Pre-School Children. .	9 min. 16 sec. ±1 min. 8 sec.	19.56± 4.79	—	—

[1] This phenomenon has been called co-satiation by Lewin (4) and Kounin (3).

A qualitative description of the process of motivation to satiation for pre-school groups upon identical and varied tasks has been presented in former papers in this series (1, 2).

The following quotations bear repetition:

"The act of repeatedly reproducing a perceived form soon leads to satiation. The individual in such a state seeks to leave the field to avoid the task that has now become annoying. His aspiration level may force him to persist but he develops mental mechanisms in the form of fantasy, hyperactive motor expression and cyclical emotional states. These are 'substitutions.'" (1, p. 80)

"The child persists and accepts the discomfort for the pressures arising from the situation are as yet insufficient to drive him from the task. Recourse is made to all the mechanisms at the individual's command. It is not long, however, before the goal assumes a negative character. Severe tensions and pressures impinge and the child desires to leave the situation. He understands that leaving the task unfinished or leaving the 'field' entirely is contrary to *E*'s authority and direction. He hesitates in violating the constituted authority. Conflict ensues between the needs to continue and the needs to discontinue. This conflict is invariably observed in the children during the trials. The child finally encapsulates himself from the task or leaves the room or breaks down emotionally. All are solutions to the conflict, but on different levels" (2, p. 266).

The sophomores required an average of 392 ± 44.53 'moon-faces' to become satiated in an average time of 17 min. 36 sec. ± 1 min. 36 sec. (Table I). Individual differences in time spent on the task ranged from 1 min. to 48 min. The average monotony-transfer time was 7 min. 22 sec. ± 38 sec. and a mean of 218.33 ± 27.85 drawings were produced in the transfer period. The differences between monotony time and quantum (i.e., number of drawings) for the two groups were statistically significant.

The mean monotony-transfer time is 41 percent of the mean monotony time. Likewise, the mean monotony-transfer quantum is 56 percent of the mean monotony quantum. This can be interpreted as saying that 59 percent and 44 percent, respectively, of the monotonous effects of drawing 'moon-faces' transferred to the immediately following and similar task of drawing 'plus-circles.' These percentage indices of monotony-transfer hold true only under the assumption that the initial monotony index (quantum and time) is a stable and valid measure of the *S*'s monotony capacity, and that the two figures are sufficiently identical to induce potentially the same degree of monotony.

It is possible to secure an insight into the process of becoming satiated by examining the protocols of several of the sophomore *S*s.

M. M.; Female; Monotony time 16 min.; Monotony-transfer time 14 min. 37 sec.

"The first figure, (˙.˙) is not as pleasant to draw nor to look at as the second figure, (+) as the placing of the three dots has more of the staccato touch and interferes with the free, sweeping movement of drawing the circles. (I would have liked better to draw a series of circles and then have gone back and put in the three dots.) Also in the first figure (˙.˙), by the placing of the dots in different positions, I created quite a number of different faces—most of which had

disagreeable expressions. I stopped drawing the first figure, because it seemed to get me nowhere; that is, I was prevented from drawing and enjoying the rhythm of the circles by having to stop and put in the dots. So soon, my purpose became to draw more nearly perfect circles, and when I had accomplished this, there seemed to be little use of continuing.

"In regard to the second figure, (+) the rhythm was achieved easier and more quickly and was more enjoyable as it did not have the jumpiness of the first figure. When I had decided what the rhythm reminded me of, and when I had succeeded in making a few fairly good circles, I didn't see what else there was to accomplish, so quit at that point."

F. G.; Female; Monotony time 7 min. 3 sec.; Monotony-transfer time 4 min.

"The first thing I thought while drawing the moon-faces was that they resembled new potatoes with small eyes. Next they reminded me of the game 'hangman' we used to play when younger. After the first few rows I wondered how I could vary the arrangement of the moon-faces (later the circles with the crosses in them) to make a more interesting design than just a plain row. Not being particularly artistic but wishing to continue I resorted to the alphabet in the later part of the second test.

"Naturally my curiosity was somewhat aroused by what value could be derived from a test such as this is. I asked several questions and had the desire to laugh a little."

These are selected but typical protocols of the entire group and comparable to those obtained from our previous experiments. They illustrate principles holding generally for monotony.

The situation with the adult *S*s is as follows:

S begins the task with a *set* formulated by his perception and anticipation of the magnitude and hedonic qualities of the task—a level of aspiration, as it were, as the work proceeds. This 'set' is a complex based upon multiple factors and undergoes more or less constant revision as the work progresses. There is usually present a more or less appropriate estimation of the quantity of work desired to be completed and the quantity actually expected to be completed. The 'set' also involves the intention of constructing the figures exactly as directed by *E*.

It is a matter of individual difference whether a 'moon-face' represents a meaningful figure or not. For the majority of the *S*s the figure actually represented a *face*, and this was often identified as some known person. Invariably a face changed expression as the work progressed. For some *S*s, no matter how drawn, the drawings were always circles and dots.

The identification of the figure as some tangible object or person serves to surround the task with goal-value; and also provides a source of *variation* as monotony is neared. Drawing pictures of 'Hitler' has more rationalization value and purpose than drawing geometrical figures. When goal-value and purposive behavior are present monotony is inhibited. In monotony, the individual constantly seeks to regain lost goal-value by goal-surrogates until even the surrogates lose their goal-value. Our *S*s attempt, in

line with this hypothesis, to construct the figures as uniformly as possible, or to preserve a single original meaning for the figures. Soon, however, accidental errors, or 'variations,' occur. These are eliminated. Then they are ignored; still later they are encouraged and sought for. The monotony level of an individual is partly dependent upon his ability to find 'variations,' to maintain them, and to divorce himself from the task. Tasks impossible of 'variations' are considered less pleasant by the *S*s. It is repeatedly maintained by the *S*s that they could go on and on if only they didn't have to draw the same figure. We may say that the continuous replication of *one* figure produces intense goal-value depreciation. If continuance is a necessity, then conflict in the individual ensues between continuing and stopping followed by unpleasantness.

There are available other means of reducing the growing monotony beyond 'variations' in the work itself. These are substitutions but not so intrinsically involved with the task itself as are the 'variations.' Attempts to engage *E* in conversation are frequent. Often the *S*s are not dismayed by a lack of response and continue to chatter anyway. Whistling and singing are common.

Most frequent of all is an active inner fantasy. The number and kinds of images reported by our *S*s would fill a good sized brochure. During this fantasy the task is quite mechanical and may proceed at no diminished rate. Such activity is often revealed by 'variations' which appear, but are not attended to and continue to be drawn. One *S* started spontaneously making *X*'s instead of plusses and was astonished when her attention was called to it. Of importance here also is the ordering of a rhythm to the construction of the figures. This is usually sub-vocal—it may be audible—but is betrayed by movements of the head, the non-preferred hand, or by the active pencil itself. Where a rhythm can be introduced, monotony is inhibited.

Of interest also is the physical and postural appearance of the sophomore *S*s, as monotony is approached. A gradual decrease in muscular coordination and increase in hand tremor is easily observable. In high degrees of monotony, the *S* is incapable of fine motor movements. In the present situation, the sophomores complained of an inability to draw round circles. Facial changes are not unlike those which occur in emotional states. The eyelids droop. There is a frown or fixed expression upon the countenance. Changes of position of the head and feet are frequent. The body droops and a typical picture of monotony is present. Not all of these symptoms appear in every individual; and not all in like degree. An *S* may require 40 min. to satiate and show little of these, whereas 10 min. in another individual produce all the symptoms.

A study was made of the two *Ss* who required 44 min. (634 drawings) and 43 min. 18 sec. (963 drawings) to satiate; and two who required 2 min. (13) and 2 min. 7 sec. (22). It is suggestive that in the former instance, both *Ss* had done work of a monotonous character; one had previously been employed as a file clerk, and the other had worked on a harvester tieing sacks with bailing wire eight hours a day. One claimed to be able to make the task almost completely mechanical; the other acknowledged only partial divorcement.

The interviews with those satiating early were not so indicative. Both of these *Ss* stated that they never could get interested in simple things which were not challenging. They both doodled excessively and were bored in many of their classes. They reported little divorcement from the task in monotonous states.

Summary and Conclusions

It was found that when pre-school children and college sophomores were given the task of drawing 'moon-faces' to monotony, the characteristics of monotony manifested by each group were closely similar. Both groups demonstrated similar facial, postural, and vocal patterns with monotony. Both groups seek 'substitutions' in the form of fantasy, talking, whistling, etc., and 'variations'—errors in work structure—encroach upon their performance.

Each rejects the task because of the conflict produced by the demands to continue and the demands to discontinue and the eventual goal depreciation.

There are, however, differences in the monotony of the two groups. The children satiate faster and draw considerably less figures; albeit their figures tend to be larger. The task of drawing 'moon-faces,' once entered, is more meaningful or on a more real plane for the children. But the 'moon-faces' as such lose meaning faster. Errors and distortions in the work structure (variations) are more profuse and elaborate. The children break off more rapidly when goal-value is lost and 'variations' have been exhausted. It is in general more difficult for them to make the task mechanical than it is for the adults, and the children find distortions of the figure easier than substitutive motor or ideational activities.

The results of our monotony-transfer experiment with adults indicate that monotony created at one task affects performance on a later and similar task, though the experiment was not completely controlled in this respect. The amount transferred to a closely similar task immediately following monotony was quite substantial, amounting approximately to an average of 50 percent. However, our findings in this respect are too incomplete to allow us to venture a hypothesis as to the basis for the transfer.

XUM

The conclusion seems warranted that monotony occurs in the same form in young children (three to five years of age) as it does in adults with essential differences due to maturation and development. The stimulative and causative factors giving rise to monotony, as far as and is known, appear to be similarly operative for child and adult.

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STUDIES OF RESPONSE GENERALIZATION IN CONDITIONING: II. THE COMPARATIVE STRENGTH OF THE TRANSFERRED AND NON-TRANSFERRED RESPONSES

BY DELOS D. WICKENS

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Problem: In previous studies (**1, 2, 3**) the writer has obtained data indicating that the conditioned response may change in form from one movement to the antagonistic movement without any additional training. The present study was designed to compare the resistance to extinction of the modified form and the original form of the response.

Subjects: The 47 *Ss* who took part in the experiment were all members of the elementary psychology class at the University of Wisconsin.

Apparatus: The apparatus was the same as that used in a previous experiment (3). Essentially, it consisted of a conditioning board, a timing disc for delivering the conditioned (tone) and unconditioned (shock) stimuli at controlled temporal intervals, and recording contacts which stopped a clock when the *S* responded. The tonal stimuli were produced by a Maico audiometer. *S* and *E* were in adjacent sound proofed rooms.

Procedure: Two groups of *Ss* were used in the experiment, 25 *Ss* being in the experimental group, and 22 in the control. The procedure for the experimental group consisted of conditioning the *S* while the hand was in one position, turning the hand over, and testing to the tone alone. For 13 of the *Ss* the training was done with the hand in a palm down position, and for the other 12 *Ss* the training was done in the reverse position. Thus, for part of the group the transferred response would consist of flexion of the finger, and for the other part, of extension. The number of each of these groups of *Ss* tested to the various tonal frequencies was, respectively, 5, 4, 4 (training with palm down) and 4, 4, 4 (training with palm up) for 256, 512 and 1024 dv/sec. stimuli. The control group was simply conditioned and tested with the hand in the same position. Eight *Ss* were conditioned to the 256 tone, and seven to each of the others. For both groups the tone used was 50 decibels above the threshold.

The directions given to the *Ss* in both of the groups were as follows:

> This is a conditioning experiment. During the experiment your hand will be strapped to this board, with your middle finger resting on this electrode, and the other electrode fastened to your wrist. You will receive a shock which will pass from one electrode to another. You can break the shock by lifting your finger from the electrode. During the experiment a tone will precede the shock by a regular interval of time. If you get conditioned, you will develop a tendency to respond to the tone before the shock goes on. I do not want you to fight against becoming conditioned, and at the same time you are not to respond voluntarily to the tone. If your finger wants to fly up, just don't inhibit it.
>
> I will start the experiment by obtaining your threshold to a tone. I will begin with a tone which will be clearly heard, and reduce the intensity of it until you cease to hear it. Then, using the same tone, I will increase its intensity until you hear it again. I want you to press on this button all the time you hear the tone.
>
> I will test for two tones in the same way.
>
> Following that I will test for the strength of the shock. Beginning with a weak shock, I will build it up until it is as strong as you want to take it. Let me know by calling out

when it is strong enough. All I want is to have it intense enough to make you lift your finger from the electrode without thinking much about it.

E went into the experimental room and obtained the thresholds for two different tones. The intensity of the shock was then adjusted to *S*'s toleration. This intensity level was used throughout the experiment unless the latent times to the shock alone began to increase much beyond the average time of the first 10 responses. If this occurred, the shock was increased to the point that the latent times were reduced appropriately.

Following these various tests, the standard procedure was then begun. This procedure consisted of:

A. Three presentations of the tone alone. The intensity of the tone was set at 50 decibels above the threshold value, and the particular tone used was of the frequency that would be employed in the final test. If any *S*s responded to the tone alone at this time, they were discarded from the experimental group. Only one *S* had to be eliminated for this reason.

B. Three shocks alone.

C. One hundred thirty paired stimulations. The time intervals between these stimulations varied from 5 to 35 sec. Two *S*s out of 47 did not show any conditioned responses as measured by anticipatory reactions during this training, and these *S*s were not continued on the experiment.

D. *Experimental.* *E* entered *S*'s room, and told *S*: "Now I want to turn your hand over so that the same finger is on the electrode, but your palm (or the back of your hand) is up." The hand was then turned over, and the recording contacts adjusted to the new position. If *S* asked any questions, *E* replied that he would answer them later.

Control: *E* entered *S*'s room and told *S*: "Now I want to give your hand a little rest before we continue with the rest of the experiment." The hand was then taken out of the apparatus for about one minute (the approximate time taken to make the necessary adjustments for the experimental group). If *S* asked any questions, *E* replied that he would answer them later.

E. Thirty sec. after *E* returned to the experimental room, he began to present the tone alone. This was presented for 15 trials. Time intervals between presentations varied, and were the same for all *S*s.

Results: The results of the experiment are presented in terms of the average number of responses given to the tone alone during the 15 test stimulations. For the experimental group, only the transferred or modified form responses are included in the averages, there being a few *S*s who responded with the same form in the two positions. The average for the experimental groups was 9.65, with a standard deviation of 5.58; and the average for the control group was 10.32 with a standard deviation of 5,08. The *t*-score comparing the differences between these two groups was only .43. This gives a probability of no difference of about 75 in 100. There is, then, no indication that there is any loss in the strength of the conditioned response as it is transferred from one muscle group to the antagonistic muscle group.

Discussion

The results of the present experiment indicate that the process of response generalization can be carried on with comparatively little or no loss in the strength of the response. It is quite possible that another experimental design might show a larger difference between the two conditions. There are several factors in this experiment which might make for near equality. For one thing, the number of acquisition trials was large, and had tests been made earlier in the

training process, a larger difference might have been evidenced. Secondly, the method of measuring the strength of the response might have hidden existing differences. It will be recalled that only 15 extinction trials were given. A number of *S*s in both groups had not shown any extinction at this time. It is possible that if the experiment had continued until extinction occurred in every *S*, the transferred *S*s might have extinguished more rapidly than the non-transferred *S*s.

Whatever the result of other experimental designs might be, the present experiment does indicate that a radical change in the form of the response can occur with little or no loss in the strength of the response.

Summary

The present experiment was designed to determine the relative strength of the transferred and the non-transferred conditioned response. Finger withdrawal responses were conditioned in two comparable groups of *S*s. For one group the hand was turned over, and for the other the hand was maintained in the same position. The frequency of responses to the conditioned stimulus alone was then determined for both groups. No significant difference between the two groups was obtained.

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MODIFICATIONS OF THE KNEE-JERK RESULTING FROM CONTINUED STIMULATION

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In a recent review of the literature on habituatory response decrement, Harris (**3**) reports only four references concerned with such decrement in the human knee-jerk. He concludes from the available studies that failure to obtain habituation within a single day is not universally the case and that there is some slight indication of habituation of the knee-jerk over a longer period of time. The present article substantiates these conclusions.

The knee-jerk, used as a measure of the general level of muscle tension, was recorded during memorization in a previously reported experiment (**2**). As a control of possible practice effects, 30 successive responses, separated by an interval of 3–5 sec., were recorded prior to memorization. The *S*s, male undergraduate students in a beginning course in psychology, each participated in three experimental sessions at the same hour on three days separated by no more than two intervening days and falling within the same week. Records of the amplitude of the knee-jerk measured in terms of muscle thickening were obtained on all three days from 26 *S*s and on the first two days from 25 others. The adjustment of the apparatus was held constant for each *S* on all three days so that results secured on the various days are comparable. The method used in recording the knee-jerk has been described elsewhere (**1**).

Habituatory Decrement.—Fig. 1 shows graphically the mean amplitude of deflection of the recording stylus for successive responses on each day of the experiment. Within each series there is a substantial decrement in amplitude, the change being greatest on the first day. Although there is partial recovery from the end of one day to the beginning of the next, a relatively large portion of the decrement persists, in that the amplitude is less at the beginning of the second and third days than it was at the beginning of the first and second respectively. This persisting modification of the amplitude of response, which may be designated as 'habituatory decrement,' is further shown by the mean amplitudes in Table I. The generality of the phenomenon is shown by the fact that the correlation of mean amplitude on the first day with that on the second is $r = .75$, where

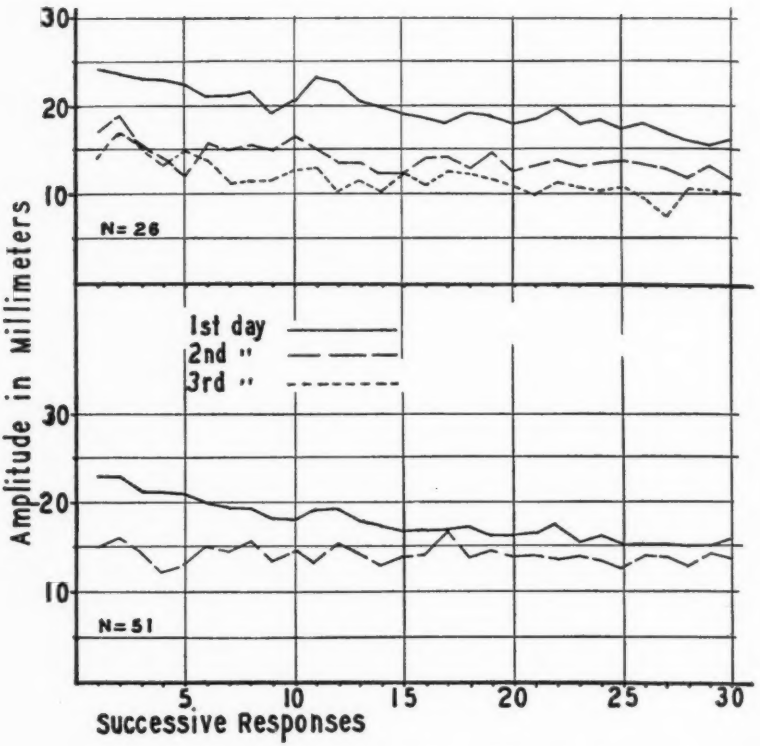

FIG. 1. Habituatory decrement of the human knee-jerk.

TABLE I

AMPLITUDE OF RESPONSE WITHIN SUCCESSIVE EXPERIMENTAL SESSIONS

N	Session	Mean (*N* = 30 for each *S*)	σ	*V*
51	1	18.3	14.5	79.2
	2	14.5	13.0	89.7
26	1	20.0	13.2	66.0
	2	14.3	12.7	88.8
	3	12.0	10.1	84.2

$N = 51$. The correlation between the first and third days, where $N = 26$, is $r = .63$.

Inter-subject Variability.—The change in the standard deviation of mean amplitudes on successive days (Table I) is in the direction of a decrease in individual differences with practice. The coefficients

of variation, however, show an increase in the variability of the group in relation to the mean amplitude. The standard deviations of amplitudes of successive responses show a slight and irregular decrease in inter-subject variability within the experimental session. For the first day these were in order: 17.5, 16.3, 17.1, 15.3, 15.5, 15.6, 15.3, 15.6, 14.8, 15.8, 15.7, 16.8, 15.1, 15.7, 13.1, 14.4, 14.9, 15.9, 15.6, 14.8, 15.0, 15.5, 14.5, 15.2, 15.3, 15.4, 14.9, 15.6, 15.6, 16.3. On the second day they were: 15.3, 16.4, 14.7, 12.2, 13.3, 15.5, 15.1, 15.9, 13.7, 14.8, 13.8, 15.7, 14.9, 13.1, 14.3, 14.7, 17.2, 14.2, 15.0, 14.4, 14.4, 14.1, 14.3, 14.1, 13.2, 14.6, 14.4, 13.5, 14.8, 14.4.

Intra-subject Variability.—In order to observe the influence of practice on variability within the individual, the series on each day was divided into three equal segments of 10 responses. This resulted in three tables of 51 rows and 10 columns for each of the first two days and three of 26 rows and 10 columns for each of the three days. The variance within the rows of each table was then computed, giving an over-all measure of intra-subject variability for each segment of 10 trials. In obtaining this value each response was considered as a deviation from the mean amplitude of the *S*'s responses within the segment of 10 trials. The variance computed in this way is partly a function of the amount of response decrement within the series. Thus, the progressive decrease in intra-subject variability for the combined group within the first experimental session (Table II) is not surprising in view of the fact that the decrement shown in Fig. 1 is progressively less for each segment of 10 trials within that day. Similarly, the fact that the variances within the third day of the experiment show little change is in keeping with the relatively slight response decrement observed on that day. Within the second day, however, the variances show a marked decrease with practice, although the response decrement is relatively slight.

Intra-subject variability is less within the first session than in either of the others. The F-ratios (4) obtained by comparing each variance of the second and third days with the corresponding value for the first day are all above the very significant level ($P = .01$). The reliability of this increase in intra-subject variability is further enhanced by the fact that the response decrement and the amplitude of response are both less after the first day.

The cause of the heightened variability of response on the second and third days is not immediately apparent. It may be that with practice variability of this response first increases and then decreases. Such a trend, although suggested by the data, is not clearly demonstrated in view of the small number of *S*s on whom records were obtained during all three days of the experiment. A tentative explanation of the increase in variability after the first day may be based on

TABLE II

INTRA-SUBJECT VARIABILITY

Session	Trials	$N = 51$		$N = 26$	
		df	Variance	*df*	Variance
1	1–10	459	27.0	234	22.1
	11–20		20.0		23.2
	21–30		18.9		22.0
2	1–10	459	43.5	234	52.9
	11–20		30.3		36.3
	21–30		28.0		30.5
3	1–10			234	33.0
	11–20				35.7
	21–30				34.7

conjectures concerning the *S*'s attitudes during the successive experimental sessions. Thus, it is possible that the novel experience of having the knee-jerk recorded for the first time served to restrict the *S*'s attention for the first few minutes to certain aspects of that experience and resulted in a relatively uniform amplitude of response. On subsequent days the novelty may have decreased, allowing an increased number and variety of stimuli to become objects of attention, which would serve to increase the variability of the knee-jerk. Moreover, variability of response on the second and third days may have been increased by the *S*'s anticipation of the memorization task which had followed the knee-jerk series on the preceding day.

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A STUDY OF THE RELATIONSHIP BETWEEN HYPNOTIC SUSCEPTIBILITY AND INTELLIGENCE

BY JAMES WYLIE CURTIS *

A survey of literature in the field of hypnotism reveals comparatively few attempts to study the relationship between intelligence and susceptibility to hypnotism. This is particularly regrettable in view of the popular belief that hypnotic susceptibility is an indication of inferior intelligence coupled with a lack of adequate 'willpower.'

C. L. Hull (**2**) states that a summary of experiments seeking the relationship between susceptibility to hypnosis and intelligence indicates a positive correlation, although the coefficient for each study was low and the techniques were varied.

Paul C. Young (**3**) quotes Friedlander and Sarbin (**1**) as stating in a 1938 report that no positive relationships between hypnotic test scores and intelligence have been established. The implications of both of the above authorities is that additional results must be obtained before a statement of the approximate relationship can be given with any degree of accuracy.

The present study was undertaken with 32 *S*s, for the purpose of obtaining additional evidence on this point. Intelligence was measured by established individual tests, and hypnotic susceptibility was measured by a scale of points made as objective as possible.

Subjects: The *S*s for this experiment were purposely selected to represent a wide variety of geographical localities, education, social background, and previous acquaintance with hypnosis. The age range is from 16 to 32 years. There were 14 male *S*s and 18 female *S*s. A rough numerical breakdown of the backgrounds of the *S*s is as follows: *Geographical Distribution*—Kentucky—13; Illinois—6; Missouri—2; New Jersey—3; West Virginia—2; New York—1; South Dakota—2; Louisiana—1; Virginia—2. *Education*—College Graduate—7; College 3 years—4; College 2 years—6; College 1 year—9; High School graduate—0; Grammar School Non-graduate—1. *Social Background*—Statistical breakdown here is difficult but the distribution would follow a curve slightly skewed toward the upper economic level. *Previous Acquaintance with Hypnosis*—Entirely unfamiliar—9; Little 'popular' information—17; fairly well informed—4; well informed—2. *Age Range*—16 through 20—10; 21 through 24—9; 25 through 28—3; 29 through 32—7.

Procedure: Each *S* was given Form L or M of Stanford-Binet Intelligence Scale. Form L was administered in each case where the *S* had not been previously given the Stanford-Binet Intelligence Scale. In a few cases where the *S* had taken Form L of the Stanford-Binet, he was given Form M for the purpose of this study. The results of the Stanford-Binet were not calculated until after the application of the hypnotic susceptibility scale, so that the *E* would be in no way prejudiced during the hypnotic measurement by the indicated intelligence level of the *S*. To rule out the time-of-day variable, all intelligence tests were begun at 4 o'clock in the afternoon.

* Under the direction of the Department of Psychology, Princeton University.

The environmental conditions under which the application of hypnotic techniques was begun were kept practically constant. In each case the hypnotic techniques were started at 4 o'clock and continued approximately until 4:20 P.M. The *S* took a comfortable chair from which the line of direct vision revealed only a dull white wall and the hypnotic fixation point. In each case, *E* sat on *S*'s left, approximately three feet to the side and two feet forward of *S*'s head. A recorder was present several feet behind *S* to check the time and record the observations, signaled by *E* on a pre-arranged plan. The afternoon selected was always one in which *S* had carried on a normal routine. Every effort was made to treat the situation as one of normal routine.

A spot of reflected light was used as the fixation point and vocal suggestions of eye closure and sleep were given. If *S* accepted the eye closure suggestion but did not pass into a hypnotic trance, the remaining battery of suggestions was given anyway. If *S* accepted the suggestion of sleep and passed into a hypnotic trance, the battery of suggestions was given as soon as this became evident.

Hypnotic Susceptibility Scale: The hypnotic susceptibility scale provides for scoring the response to the following suggestions: 1. Eye closure; 2. sleep; 3. analgesia to pinch on wrists; 4. analgesia to slight burn on back of hand; 5. arm catalepsy; 6. hand catalepsy; 7. hallucination as to existence of a book; 8. hallucination as to a fly on the nose; 9. performance of a post-hypnotic suggestion; 10. existence of post-hypnotic amnesia; 11. response to attempted reinduction of hypnosis five minutes after awaking from original trance, if any.

The suggestions were given only once to each *S*, and always in the same order. The response to a suggestion was scored two points if it was involuntary and apparently a bona fide hypnoidal or hypnotic reaction. One point was given for each suggestion only partially completed or done in a slow or unsatisfactory manner. No points were awarded if the response to a suggestion was considered in any way due to conscious volition or did not appear to be a true hypnotic or hypnoidal response.

Results: The following scores were obtained from the thirty-two *S*s:

Subject	Hyp. Sus. Scale	Stanford-Binet	Subject	Hyp. Sus. Scale	Stanford-Binet
MJ	22	136	TF	0	101
DJR	6	106	AEH	22	128
HIR	20	116	RR	16	122
SRB	8	139	JM	13	111
IC	0	103	SN	7	129
JDC	17	126	WP	10	117
MC	21	131	FW	6	116
JLF	13	137	SR	16	129
BHH	14	144	HF	13	109
MEG	5	130	CEF	0	103
DC	6	133	MM	0	104
SS	4	123	HMD	0	111
GG	9	134	JMD	12	131
FES	8	132	GA	4	112
MMS	6	117	GH	12	134
MLC	0	128	TF	0	101

1. The Pearson *r* obtained was .502, with a standard error of .180. The coefficient is significant at the one percent level.

2. A point scale for evaluating the degree to which the individual has been hypnotized lends precision to studies dealing directly or indirectly with hypnosis, and from personal observation, tends to influence the experimenter toward a more objective consideration of the factors involved during the hypnotic trance.

3. It was found that a fraction over 40 percent of the *S*s were hypnotizable. This is believed to be due to the efforts of *E* to treat the period of experimentation with a casual attitude and a studied attempt to eliminate emotional reaction on the part of *S*, with reference to hypnosis. It is suggested that this type of approach prevents the formation of subconscious 'blocks' or resistances.

(Manuscript received August 26, 1943)

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A 'UNIVERSAL' APPARATUS FOR RESEARCH IN PHYSIOLOGICAL OPTICS

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Many of the facts needed for the construction of a complete theory of vision are presumably yet to be discovered. Many of those commonly supposed known are probably inaccurately stated and improperly interpreted because of the unavoidable dependence of statement of fact upon a previously established conceptual system. A non-conformist fact is often an ideological pariah.

This state of affairs may be traced, at least in part, to the custom of partial theorizing, i.e., to the treatment of a restricted set of facts as if they constituted a closed system. Thus, for vision, we have theories of chromatic discrimination, theories of contrast, theories of after-effects, or transient phenomena, theories of acuity, theories of binocular vision, and so on, but no theory of vision. But there are recognizable trends toward an integration of the traditional plurality of theories. The irreverent hurdling of boundaries between long-established categories by the phenomenologists and the Gestalt psychologists has perhaps been occasionally mildly shocking for those who adhere to the analytic approach of classical tradition. Yet there are facts and phenomena which demand reconciliation and integration of hitherto discrete concepts. How, for example, can one accept the Liebmann effect, Mach rings, the several varieties of the Fechner-Benham phenomenon, the dependence of chromatic contrast upon boundary conditions, etc., without admitting that the spatial, temporal and chromatic aspects of vision are essentially inseparable and demand not a plurality of theories, but one theory?

Facts emerge from concrete situations, and in the fields of physiological and psychological optics, such situations are mostly experimental. Logically, the plan of the experiment and the design of the needed apparatus is of fundamental importance, and hence arises a dilemma that appears to have no ideal solution. The experimenter naturally desires to obtain a definite and 'important' fact, but the dimensions of his experiment must be finite. Hence he must decide, consciously or not, that some of the details of the experiment are 'unimportant.' How can he be sure that the face-value of his fact is its true value? He can, of course, repeat the experiment; but, too often, he does not do so, and when someone else attempts to do

so he cannot be certain of success because not all of the details of the original experiment can be known to him.

These considerations suggest the desirability of constructing a 'universal' experimental situation. Of course, complete universality is not meant, but only a high degree of flexibility, such that experiments of many different kinds, representative of many or all of the traditional categories, may be performed within essentially the same gross experimental matrix.

It is assumed, then, that the following description of apparatus will not seem anti-climactic.

The general requirements which this apparatus was designed to meet are as follows:

(*a*) An independently controllable field of vision for each eye, both simultaneously visible, or not, as desired. To meet the ideal of 'universality' these fields should be at least 180° in diameter, but there appear to be practically insuperable optical difficulties preventing achievement of this goal, if the other important requirements are also to be met. Actually, the fields provided by the apparatus herein described are only slightly more than 18° in diameter. It remains to be seen how serious this limitation is.

(*b*) Each field divisible into subregions of independently controllable illuminations, separated by the sharpest possible boundaries. Means for blurring these boundaries to any desired and known degree.

(*c*) Provision for use of any desired pattern of subregions in each field.

(*d*) Means for introducing any desired pattern of intermittence or variation into the illumination of any subregion of the field independently of the pattern of intermittence or variation in other subregions. Means for introducing any desired phase relation between the temporal patterns of different subregions.

(*e*) Provision for adjustment of the apparatus to different interocular distances so that the phenomenal fields of right and left eyes can be made to coincide in space. Hence, by means of high speed shutters in the eyepieces, the left eye field can be replaced, practically instantaneously, or after a known interval, if desired, by the right eye field, or vice versa, without phenomenal spatial displacement and with no requirement for eye movement.

These requirements are met thus (Fig. 1):

(1) For each eye there is a 'tank' of complex form, consisting of a central cylindrical section (*A*, *A'*), inside diameter, $4\frac{1}{2}$ in., a conical section (*C*, *C'*), terminating with an eyepiece (*E*, *E'*), a cylindrical section of smaller (3 in., inside) diameter, (*D*, *D'*), side branch(es),

S_1, S_2, and S', and slide-frames Sl_1, Sl_2 and Sl'. The inside diameter of S_1, and S' is $4\frac{1}{2}$ in., the same as that of the central section, and the diameter of S_2 (inside) is 3 in. These 'tanks' are made of brass tubing, the various sections being joined by silver solder to form a rigid, oil-tight structure. In the open ends of the side-branches and posterior sections, clear glass discs are sealed by Glyptol, supported by retaining rings, all seals being oil tight. Just outside of each clear disc and brought into complete optical contact with it by a film of clear mineral oil, there is a disc of flashed opal. Each flashed opal disc is illuminated by the corresponding lamp and lens system. The entire 'tank' is filled with clear mineral oil (index of refraction, 1.481). Baffles (not indicated in the figure) are inserted at strategic points to form light traps, and the entire internal surface is painted black to minimize indirect illumination of the flashed opal discs.

(2) The small end of the conical section of each of these 'tanks' is fitted with an eyepiece section (E, E') the function of which is two-fold: (*a*) to provide the offset necessary to reduce the distance between apertures to the inter-pupillary distance of the subject, and (*b*) to provide the necessary adjustment of the convergence angle. The form of the eyepiece is shown in greater detail in Fig. 2. The critical features are the two reflecting surfaces R_1 and R_2, the glass window, W, through which the light finally emerges from the oil-filled interior, and the replaceable artificial pupil, P. R_2 is simply a plane disc of clear glass cemented into a recess in the body of the eyepiece with Glyptol, and further supported by an external retaining ring. R_1 consists of two pieces of carefully selected microscope slide glass separated by a spacer of brass shim stock a few thousandths of an inch thick, the entire assembly being cemented around the edges with Glyptol so that a sealed air space remains between the two glass plates. This arrangement permits total reflection at the air-glass surface, since the shape of the eyepiece is such that the angle of incidence of the most extreme ray of light for the extreme convergence angle is greater than the critical angle (41° 14″ for glass of index 1.517). Total reflection occurs also at R_2 at the external surface of the glass inset. A simple inset of glass could not be used for R_1, however, because provision must be made for adjustment of the convergence angle when it is desired to make the right and left fields of vision coincide in phenomenal space. R_1 is pivoted near one end (M) by two small steel points fixed in the body of the eye-piece, one at the upper edge of R_1, the other at the lower edge. For each of these points a small recess is ground in the glass to prevent slipping out of place. (These details are not shown since the figure is a horizontal section through the eye-piece.) One end of a flat spring, S, is soldered to the inside of the cover plate, N, and the other end

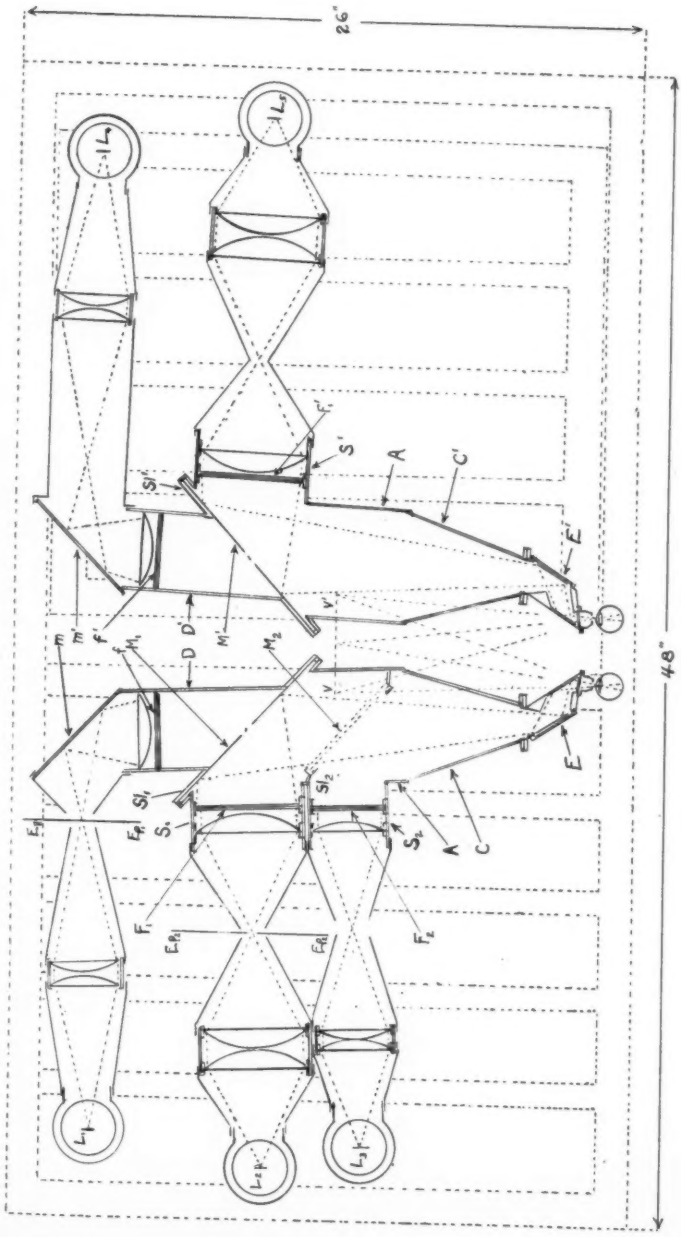

FIG. 1. Diagram of the apparatus.

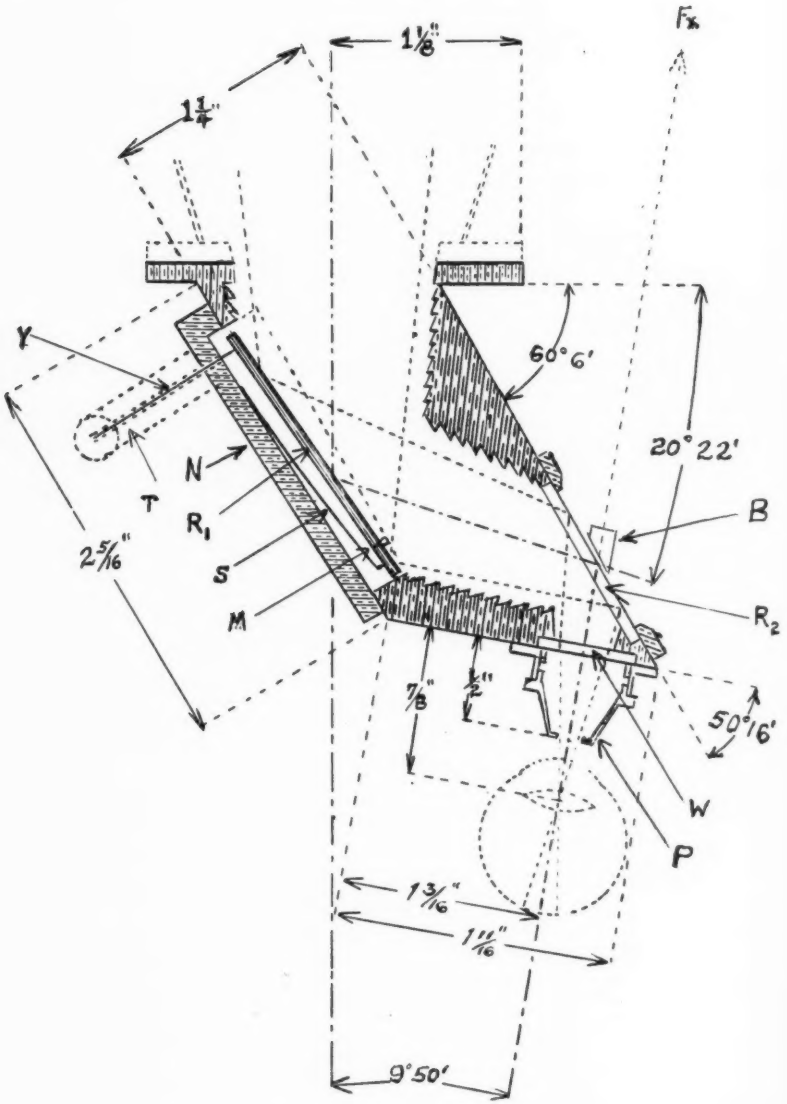

FIG. 2. Details of the eyepiece.

bears against the extreme end of R_1. At the other end of R_1 the action of the spring is resisted by a fine steel wire, Y, which slides in the small-bore tube T. This tube is bent upward and its vertical

portion is long enough to extend above the level of the oil in the 'tank.' The steel wire is attached to a screw at the upper end of the tube, by means of which the wire can be made to slide upward or downward. The lower end of the wire, against which R_1 rests, thus withdraws into or emerges from the tube, and causes R_1 to swing outward or inward. Hence the direction of the light emerging from W can be varied. Reflection of light from the interior surfaces of the eye-piece is minimised by the series of skewed V-grooves cut in these surfaces after the completion of the main boring operation, and by a coating of black paint.

When desired, a fixation point can be provided in either of two ways: (*a*) by means of a small mirror at approximately 45° to the optical axis just outside window W, mechanically moved aside at the instant the previously dark field is illuminated, or (*b*) by means of a small glass or lucite block, B, making optical contact with R_2 in the neighborhood of the point of reflection of the central ray from the field. Through such an arrangement a fixation point, Fx, situated on the prolongation of the optical axis of the eye will be visible. Of course, as soon as the field is illuminated, optical contact of this block must be broken. A magnetically operated mechanism, which moves the block a practically infinitesimal distance into or out of contact with the surface of the glass inset, fulfills this requirement.

(3) Returning now to Fig. 1, it will be seen that if a plate-glass silvered mirror is inserted in slide frame Sl_1, the eye at E will see the virtual image of the luminous flashed opal disc in S_1. Reflection will occur almost exclusively at the silver surface, since the refractive index of the glass-oil surface is so nearly unity that only a negligible fraction of the light will be reflected by it. If, however, some of the silver is removed from the plate-glass mirror, care being taken to avoid scratching the glass, then a corresponding portion of the luminous disc in D will be visible. Consequently the field of vision will contain two regions, of practically completely independent luminosities separated by a boundary line of maximum sharpness. The nature of the boundary is determined by the edge of the silver coating of the mirror. Since this silver film is very thin, the limit of sharpness of boundary (physically considered), set by the unavoidable diffraction, is probably reached. The principles involved are, of course, almost identical with those of the 'cube' of the Lummer-Brodhun photometer head.

(4) It will also be clear, from an examination of Fig. 1, that if a second mirror is inserted in Sl_2, suitable portions of its silver coating having been removed, the field of vision will be divided into three regions (in the simplest case), each of independently variable luminosity. The number of regions into which the entire field may be divided is, of course, almost unlimited, but the important feature is the possi-

bility of three independently variable luminosities. Since the various mirrors are removable and may be replaced by others, the variety of patterns available is limited only by the amount of time the experimenter wishes to spend removing silver from glass.

(5) The foregoing description of the optical properties of that portion of the system which controls the field of vision for the left eye applies also to the other portion corresponding to the right eye, except that in the right field of vision only two independent luminosities are available.

(6) The entire apparatus is mounted upon a stand constructed of welded angle iron, channel iron, and commercial steel bench legs. The top of this stand is indicated by the dotted lines of Fig. 1 (other than those used to indicate extreme rays of light within the optical system). But the 'tank' for the right eye, and its associated lens holders and lamp houses is mounted on a rigid frame which slides horizontally within the main framework. Thus, the distance between the right and left apertures may be adjusted to suit the interpupillary distances of different subjects.

(7) Two episcotisters, Ep_1 and Ep_2, are so mounted that they cut the paths of light at the common foci of the condensing and collimating lenses. These episcotisters are supported from the floor by a rigid overhanging iron framework entirely separate from the stand which supports the apparatus already described. Thus, vibration due to the operation of the episcotisters can be prevented from reaching other parts of the apparatus to any appreciable degree. The driving motor is a direct current, variable speed motor, equipped with a twenty-eight pound flywheel and mounted in the base of the framework which supports the episcotisters. The two episcotister spindles are connected by a chain and sprocket wheel drive so that synchronism is maintained. Further, the episcotister discs may be rotated and locked in any position on their hubs so that any desired phase relation may be established between the interruptions of the two beams of light. Finally, each episcotister disc is equipped with removable sectors providing several ratios of dark interval to complete cycle.

An automobile type speedometer is connected to the driving mechanism of the episcotisters and calibrated in flashes per second.

(8) Immediately in front of the two eye-pieces a framework supports a forehead rest, a removable tooth-bit of dental wax, and a hood fitting the subject's head and excluding room illumination from his eyes. The forehead rest and tooth-bit are capable of adjustment in all necessary directions so that both eyes of the subject may be centered simultaneously on the apertures, acting as artificial pupils, of the eye-pieces. Moreover, the forehead rest and wax tooth-bit makes it possible for the subject to resume quickly and easily the

correct position after an interval of rest. This part of the apparatus has been omitted from Fig. 1.

(9) Illumination of the various diffusing surfaces in the optical systems is provided by 12 volt, 240 watt, prefocussed airplane headlight bulbs. Each bulb is mounted in its own water-cooled lamp house. The bulbs are connected in series, together with suitable additional resistance, in a 75 volt direct current circuit from a 10 kilowatt motor generator set. The generator is provided with a voltage regulator, and when the latter is well adjusted, fluctuations of line voltage are small and for most purposes negligible.

There is also provision for the introduction into the light beams of heat-absorbing cells through which distilled water is circulated by a centrifugal pump so designed that the water cannot come into contact with its bearings. Thus, the water, and hence the internal surfaces of the glass window of the heat-absorbing cells, remains clean for long periods of time.

Chromatic illumination of the various fields may be produced, of course, by the use of filters, but the over-all design of the apparatus also contemplates the use of monochromatic illumination. The apparatus is already equipped with sodium vapor lamps, the circuits of which have been modified so that the lamps may be operated on direct current. Such lamps, in conjunction with filters to remove the feeble red and green lines of their spectra, yield a satisfactorily monochromatic light. But to provide other monochromatic illuminations prismatic auxiliaries will be necessary. These have not yet been provided.

The beams of light are completely inclosed, except for narrow gaps in the shielding for the episcotister discs, as indicated in Fig. 1. Hence room illumination has no effect on the illumination of the fields. This provision, together with that for shielding the subject's eyes, make it possible to carry on all experimental work in a well-lighted room.

Continuous variation of illumination intensity involved problems that have not yet been completely solved. In investigations not requiring more than about 40 percent of the light provided by the source, a pair of Polaroid films, mounted so that the angle between the axes is variable, is the obvious choice.

When continuous variation in the higher illuminations is needed, the use of calibrated optical wedges is planned. These will be made of lengths of slow, fine-grain, contrast film in strips about $4\frac{1}{2}$ in. wide, and used between the two parts of the condensing lens where a safe temperature can be maintained by means of air jets.

The maximum achromatic brightness of the large field in the left optical system is by direct measurement 501 ml. There is considerable absorption of light in the long optical path through

the oil-filled tank, to wit, about 39 percent. But at present there are no reflectors behind the lamps. Accurate placement of spherical mirrors behind these lamps should nearly double the maximum field brightness.

(10) In Fig. 1, the dash line VV' indicates the theoretical position of the coinciding virtual images of the two large fields for an interpupillary distance of 72 mm. and corresponding convergence angle. The distance from these virtual images to the eyes is, of course, less than the distances ($19\frac{3}{8}$ in.) from the luminous surfaces to the corresponding eyes because all but $\frac{1}{2}$ in. of the optical path from luminous surface to the cornea of the eye is in a medium (oil, or glass) that is optically denser than air in the ratio of 1.481 to 1, or 1.517 to 1. The optical distance is consequently shorter than the geometrical distance in the same ratio.

What is more pertinent, the boundary line between two subregions of the field (e.g., when a central spot is formed by absence of silver in the central part of the mirror in Sl_1) is even closer, optically, to the eye than is the virtual luminous surface VV', since its geometrical distance from the eye is less than the geometrical distance of the real luminous surface. And, since the mirror makes an angle of 45° with the optical axis of the system, different parts of the boundary line are unequally distant from the eye. This state of affairs is not, of course, a desirable one, for it means that not only will maximum or nearly maximum accommodation be required in all eyes except considerably myopic ones, but also that even then accommodation cannot be correct for all parts of the boundary line. The first part of this difficulty can be avoided by the use of a positive lens of suitable strength instead of a disc of plane glass in the window, W, of the eyepiece, or by the addition of a plano-convex lens immediately outside this window and in optical contact with it through an oil film. The second part of the difficulty is unavoidable, in any apparatus of dimensions comparable with the dimensions of this one. Further, an additional difficulty of the same kind arises when in the left optical system all three luminous surfaces are used, with mirrors partly desilvered, in both Sl_1 and Sl_2. Such difficulties could be avoidable only in apparatus of such large dimensions that all virtual images would be at optical infinity for the eye.

(11) The accommodation difficulties discussed above impose certain limitations upon the auxiliary apparatus planned (but not yet constructed) to produce calibrated gradation of blurring of the boundary lines of the visual patterns in the field of vision of one eye. The usual method, that of 'fogging' the field of vision by means of a lens, has the disadvantage that the extent to which the effect of the lens is partially compensated for by an extra effort of accommodation is unknown. A method of producing blur that cannot be even

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partially corrected by any lens is needed. Such a method may be based upon the fact that two cylindrical lenses of equal strength but opposite sign practically neutralize each other when their axes are parallel, if they are not very thick and if their separation is small. But if the axes are at right angles, astigmatism is produced of a degree depending on the strength of the lens. If the angle is less than 90°, then the degree of astigmatism is reduced by an amount which can be calculated from the lens constants, and the angle between their axes, to a first approximation at least. Now if such a pair of lenses is made to rotate on an axis coinciding with the optical axis, then the axis of astigmatism rotates, and if the speed of rotation is very great blurring will result in the image of any luminous point seen through the rotating lenses. No lens can reduce such blurring in the slightest degree. It is planned to mount two cylindrical lenses of opposite sign, and about $\frac{3}{8}$ in. in diameter, in a ring in such a way that the angle between the axes can be set at any desired value, and to mount this ring in roller bearings at the aperture of the eye-piece so that it can be rotated at high speed by means of a jet of compressed air.

It is believed that the various degrees of blurring of theoretically known amount thus possible will be of considerable experimental value in such a case as, for example, a single vertical, narrow figure in the center of the large field. This requires the use of a mirror in Sl_1 only, and the difference between the optical distances of the two sides of the figure will be so small that imperfections of accommodation for one or both of them will not seriously complicate the effects of blurring produced in the above described manner.

Thus, all of the general requirements for an apparatus having a wide range of usefulness in research in physiological optics have been met, or nearly met. The left eye portion of the apparatus has already been used (Gebhard, 1) in a study of Fechner-Benham colors in a stationary spatial pattern. The writer expects to continue, in the near future, his quantitative investigations of contrast, begun several years ago with very crude apparatus, with results not published and chiefly valuable only as the point of departure for the design of the present apparatus. Other fields of investigation to which this apparatus may be readily adapted are: adaptation, afterimages, possibly some aspects of stereoscopic vision, and the psychophysics of interocular discrimination.

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Reference

1. Gebhard, J. W. Chromatic phenomena produced by intermittent stimulation of the retina. (To appear in *J. exp. Psychol.*)